US009467036B2

(12) **United States Patent**
**Bootsma, Jr.**

(10) **Patent No.: US 9,467,036 B2**
(45) **Date of Patent: Oct. 11, 2016**

(54) **DEVICES AND METHODS FOR MECHANICALLY COUPLING MAGNETIC FIELD INDUCED MOTION**

(71) Applicant: **NEODYMIUM ENERGY LLc**, Melville, NY (US)

(72) Inventor: **Pieter Bootsma, Jr.**, Oakland Gardens, NY (US)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 337 days.

(21) Appl. No.: **14/051,642**

(22) Filed: **Oct. 11, 2013**

(65) **Prior Publication Data**

US 2014/0111049 A1 Apr. 24, 2014

**Related U.S. Application Data**

(60) Provisional application No. 61/713,129, filed on Oct. 12, 2012.

(51) **Int. Cl.**

| | |
|---|---|
| ***H02K 21/00*** | (2006.01) |
| ***H02K 53/00*** | (2006.01) |
| ***H02K 49/10*** | (2006.01) |
| ***H02K 16/00*** | (2006.01) |

(52) **U.S. Cl.**
CPC .............. ***H02K 53/00*** (2013.01); ***H02K 16/00*** (2013.01); ***H02K 49/10*** (2013.01)

(58) **Field of Classification Search**
CPC ... H02K 49/104; H02K 53/00; H02K 49/102
USPC .......................................... 310/152, 80, 103
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 2,745,027 A * | 5/1956 | Williford, Jr. | H02K 49/10 | 310/103 |
| 2,921,468 A * | 1/1960 | Treff | G01F 3/12 | 310/104 |
| 3,935,487 A | 1/1976 | Czerniak | | |
| 4,179,633 A | 12/1979 | Kelly | | |
| 4,196,365 A | 4/1980 | Presley | | |
| 4,517,477 A | 5/1985 | Pankratz | | |
| 4,598,221 A | 7/1986 | Lawson et al. | | |
| 5,712,519 A * | 1/1998 | Lamb | H02K 49/046 | 310/103 |
| 6,274,959 B1 | 8/2001 | Uchiyama | | |
| 6,433,452 B1 | 8/2002 | Graham | | |
| 6,455,975 B1 | 9/2002 | Raad et al. | | |
| 6,811,106 B2 | 11/2004 | Aikawa | | |
| 8,288,904 B1 | 10/2012 | Bootsma, Jr. et al. | | |
| 2005/0116579 A1 | 6/2005 | Ohiwa et al. | | |
| 2008/0246361 A1* | 10/2008 | LaPoint | H02K 57/003 | 310/156.01 |
| 2010/0207472 A1* | 8/2010 | Atallah | H02K 49/102 | 310/103 |

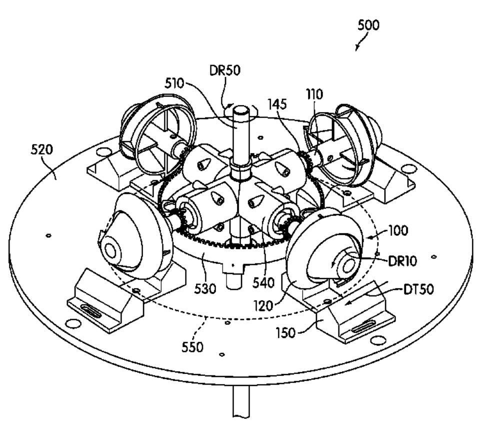
* cited by examiner

*Primary Examiner* — Thanh Lam

(57) **ABSTRACT**

Apparatus for coupling magnetic forces into motive force includes a spinner shaft on which a helical array of magnets is mounted and a magnetic power bed. The magnetic power bed includes first and second magnetic boost elements configured to interact magnetically with the helical array of magnets to cause the spinner shaft to rotate as the helical array of magnets passes between the first and second magnetic boost elements. the first magnetic boost element includes two magnets separated by a magnetically responsive material and the second magnetic boost element includes a single magnet, thereby defining a tri-field magnetic flux within the magnetic power bed. The magnetic power bed may further include an auxiliary power bed that interacts with the first and second magnetic boost elements and the helical array. The apparatus may include two or more magnetic power bed with one or more magnetic field shunt bridges extending between the magnetic power beds.

**33 Claims, 20 Drawing Sheets**



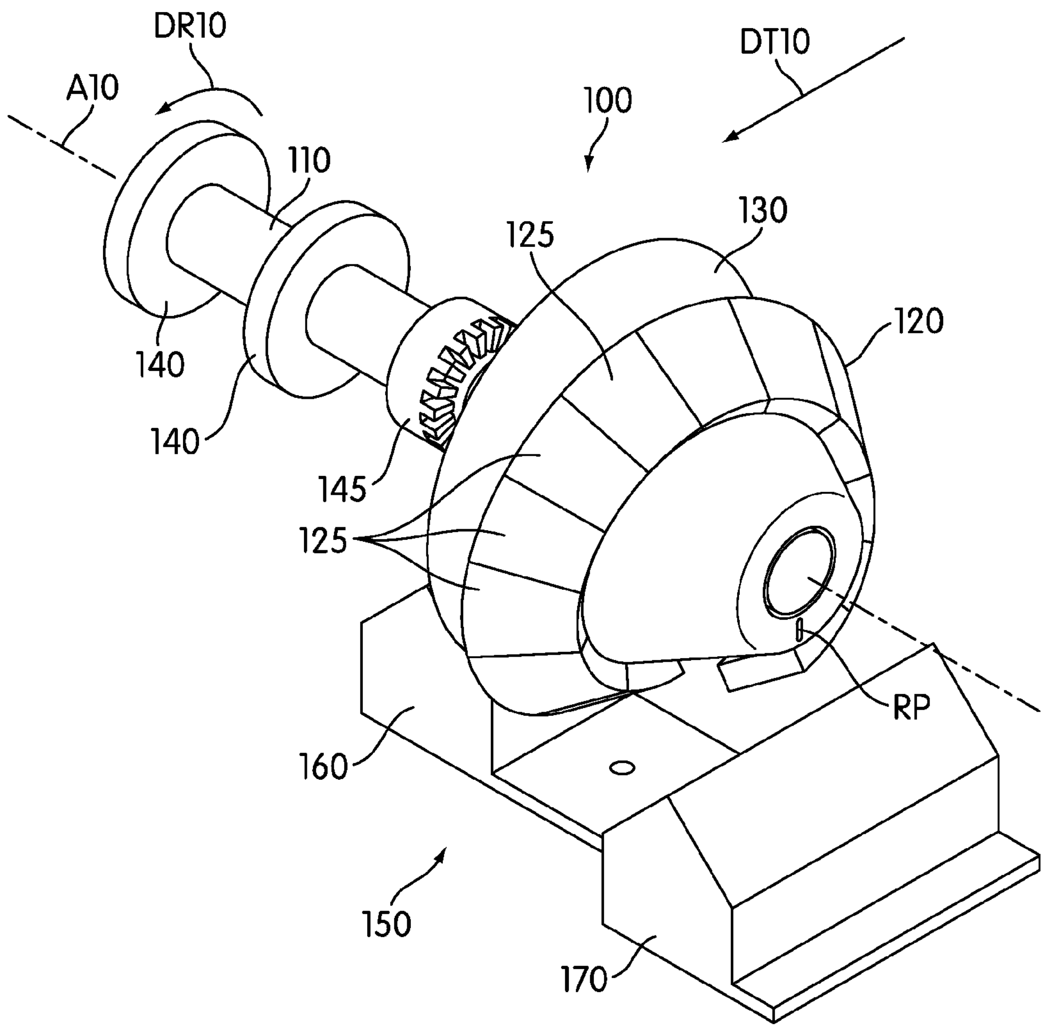



FIG. 1

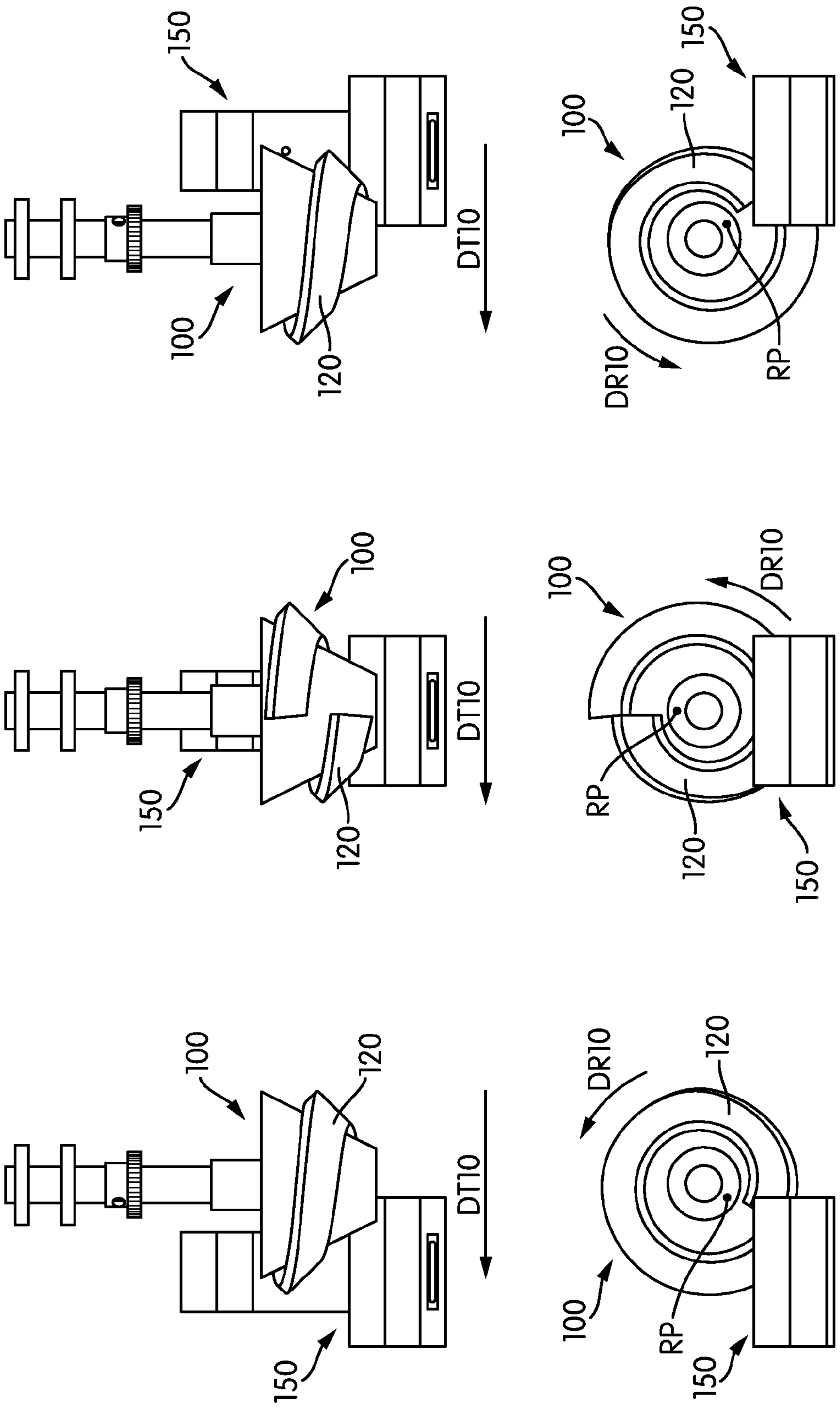



FIG. 2A

FIG. 2B

FIG. 2C

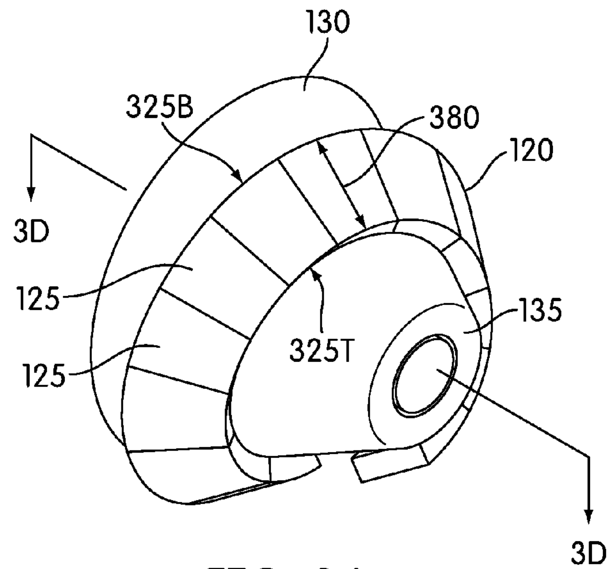

130
325B
380
120
3D
125
125
325T
135
3D

FIG. 3A

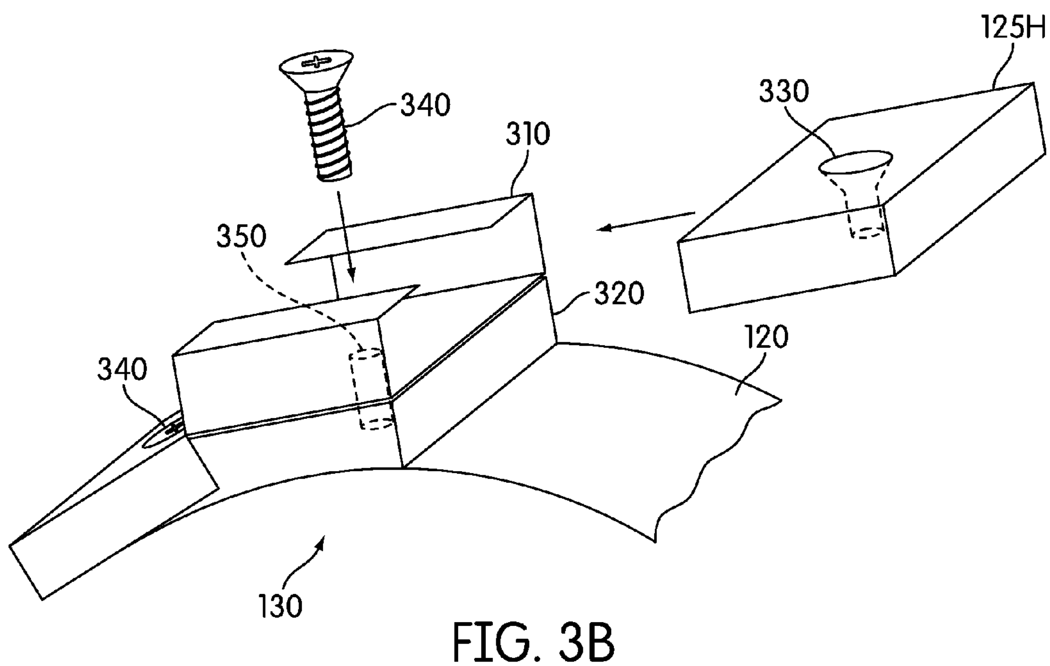

125H
340
330
310
350
320
340
120
130

FIG. 3B

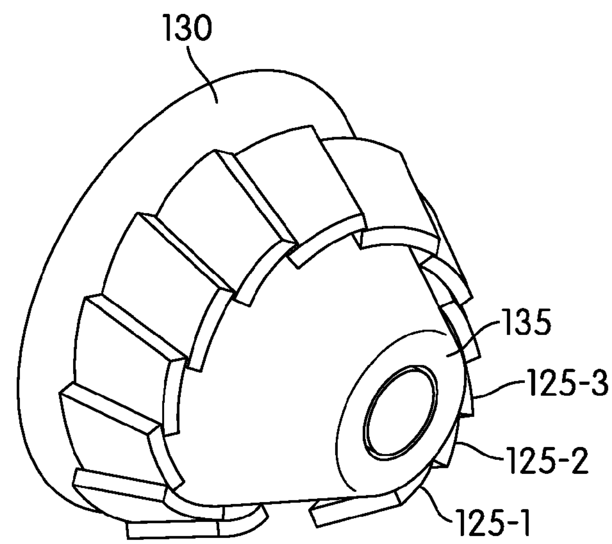



FIG. 3C

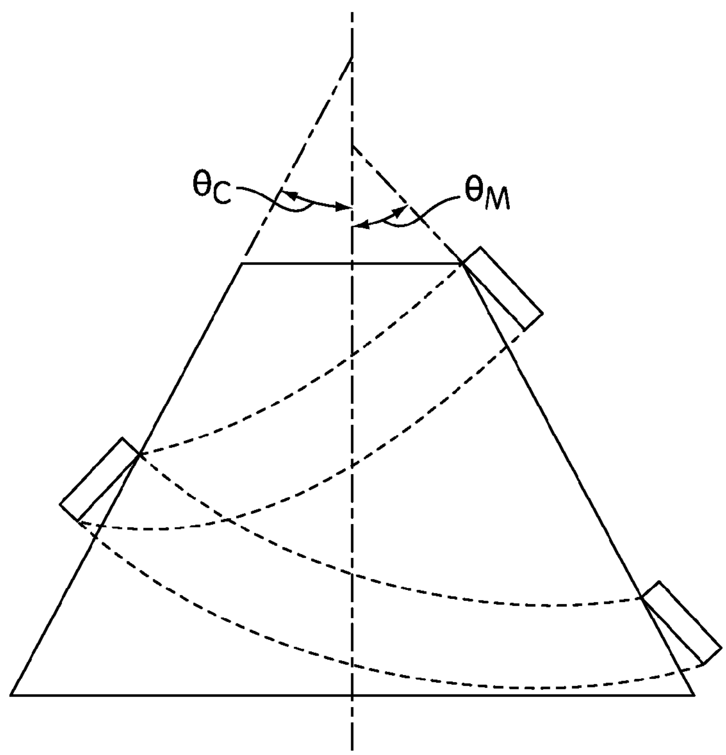



FIG. 3D

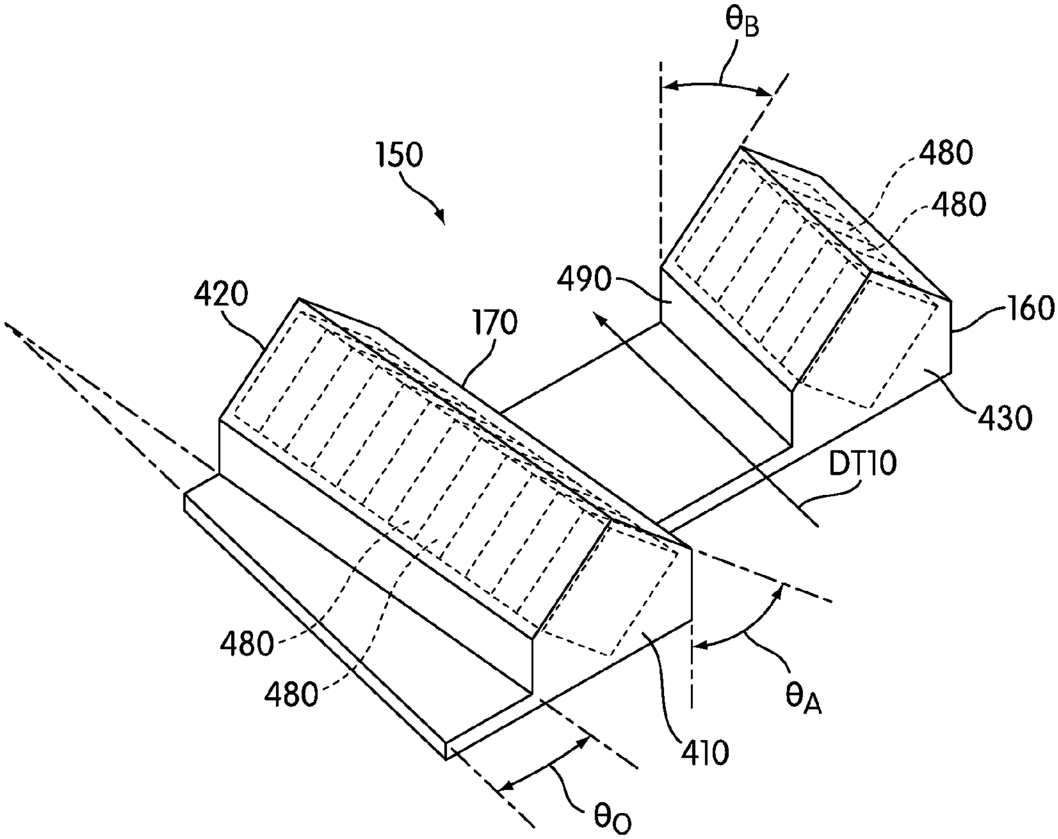



FIG. 4A

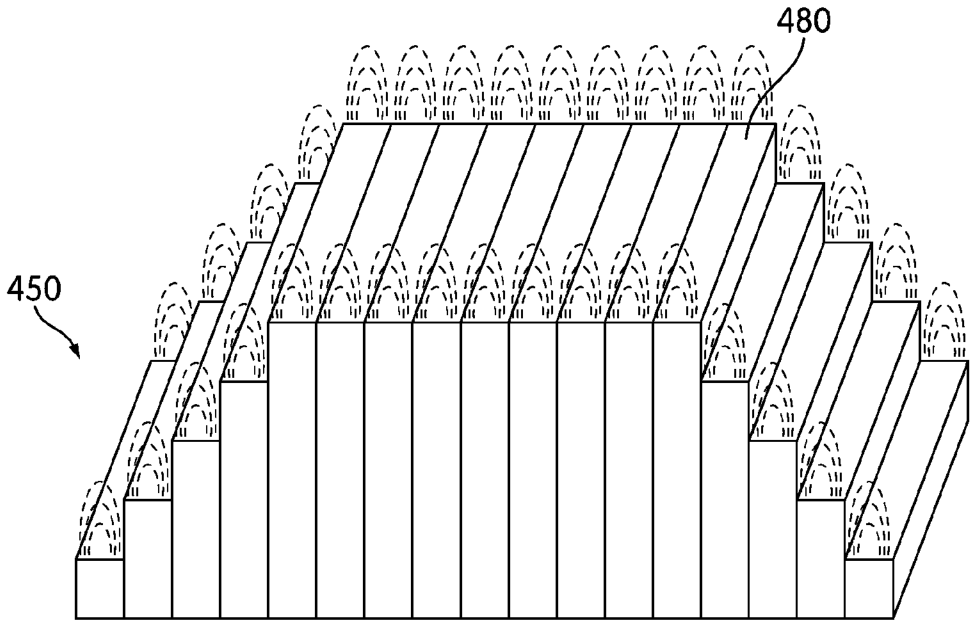



FIG. 4B

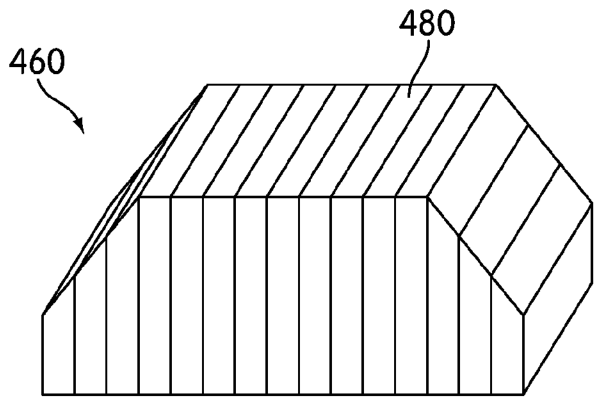



FIG. 4C

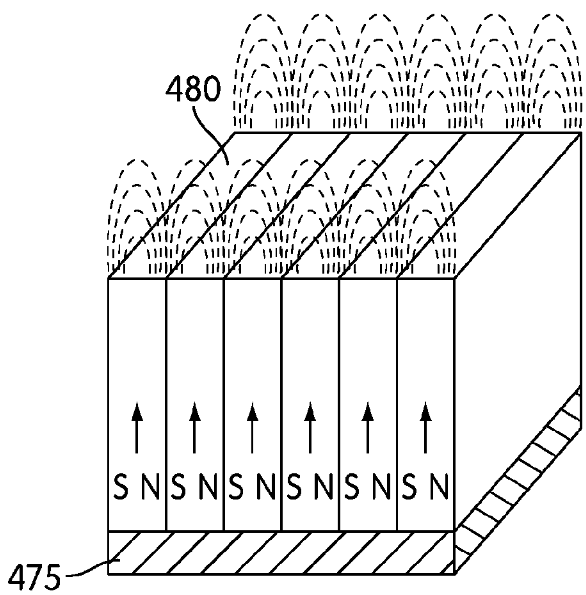



FIG. 4D

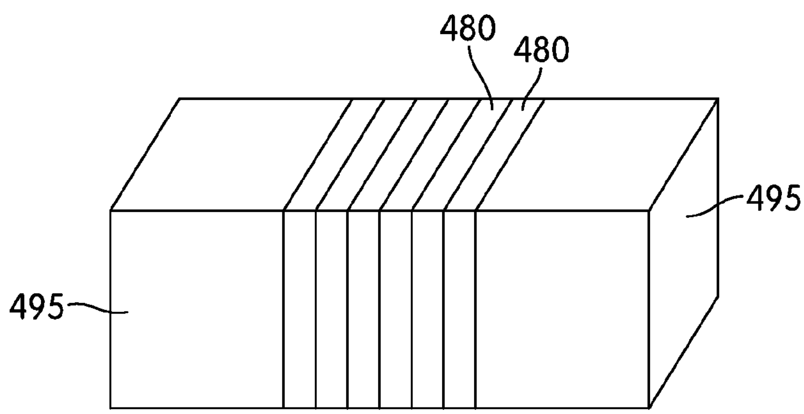



FIG. 4E

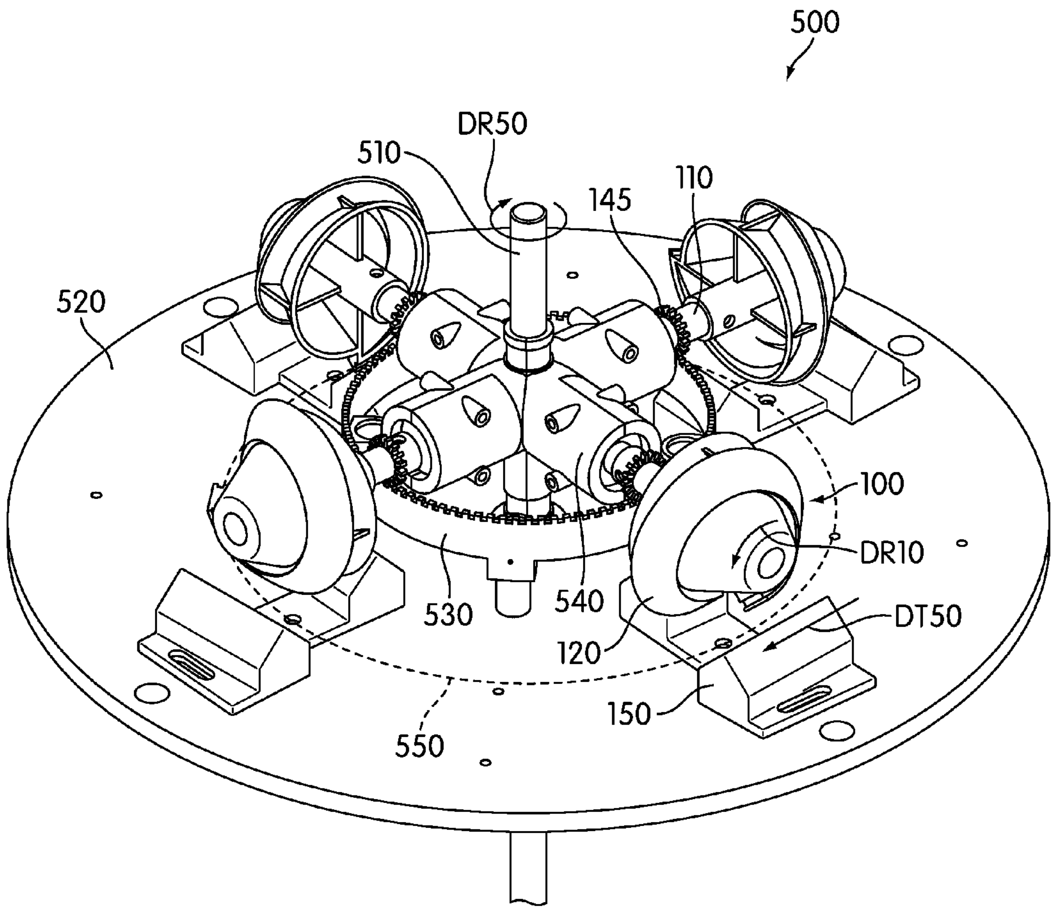



FIG. 5

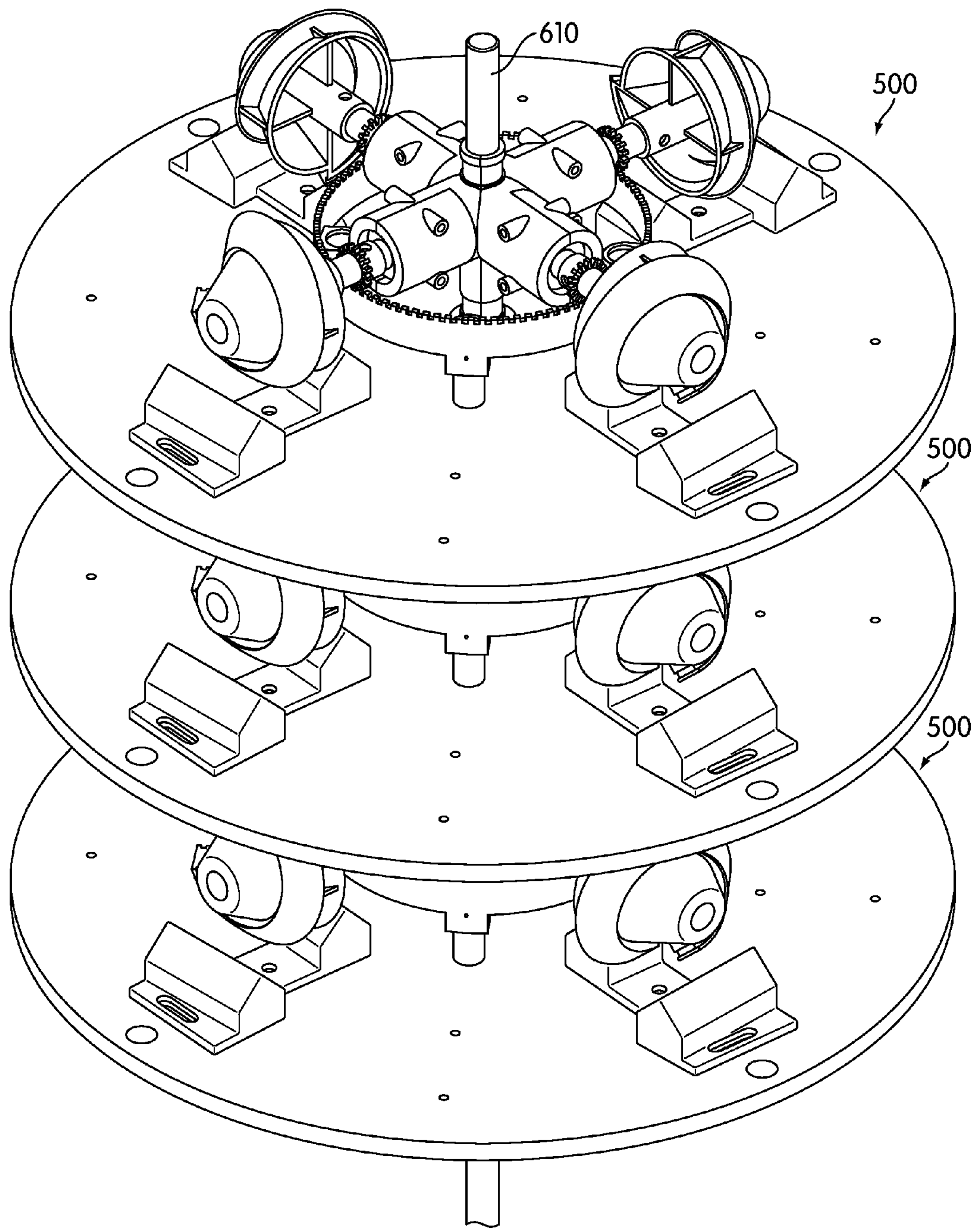



FIG. 6

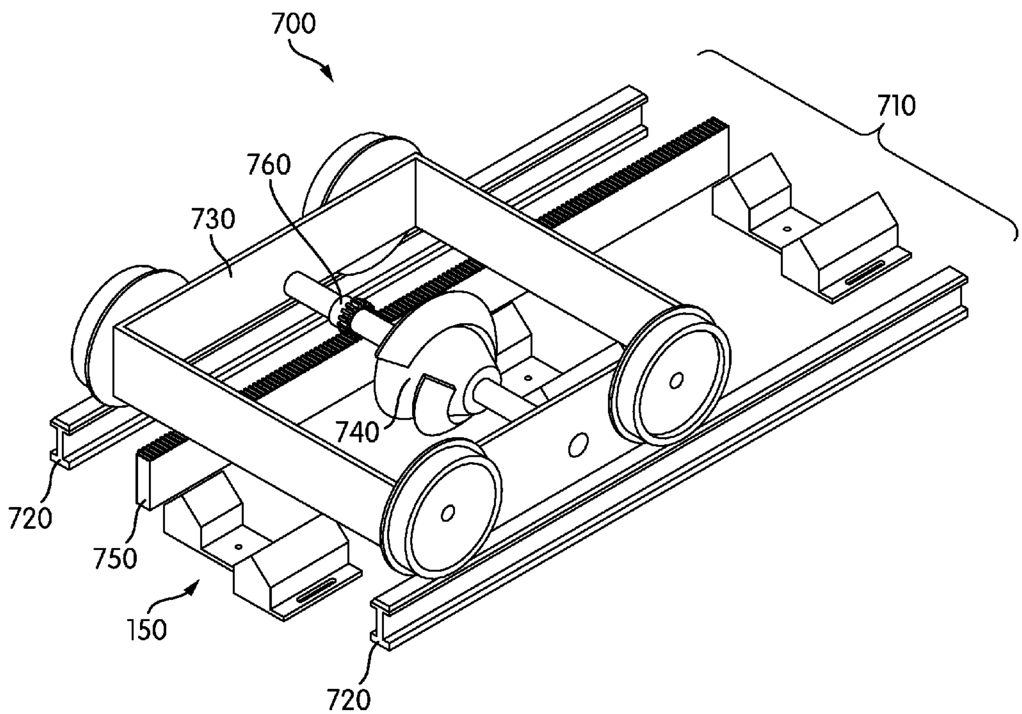



FIG. 7

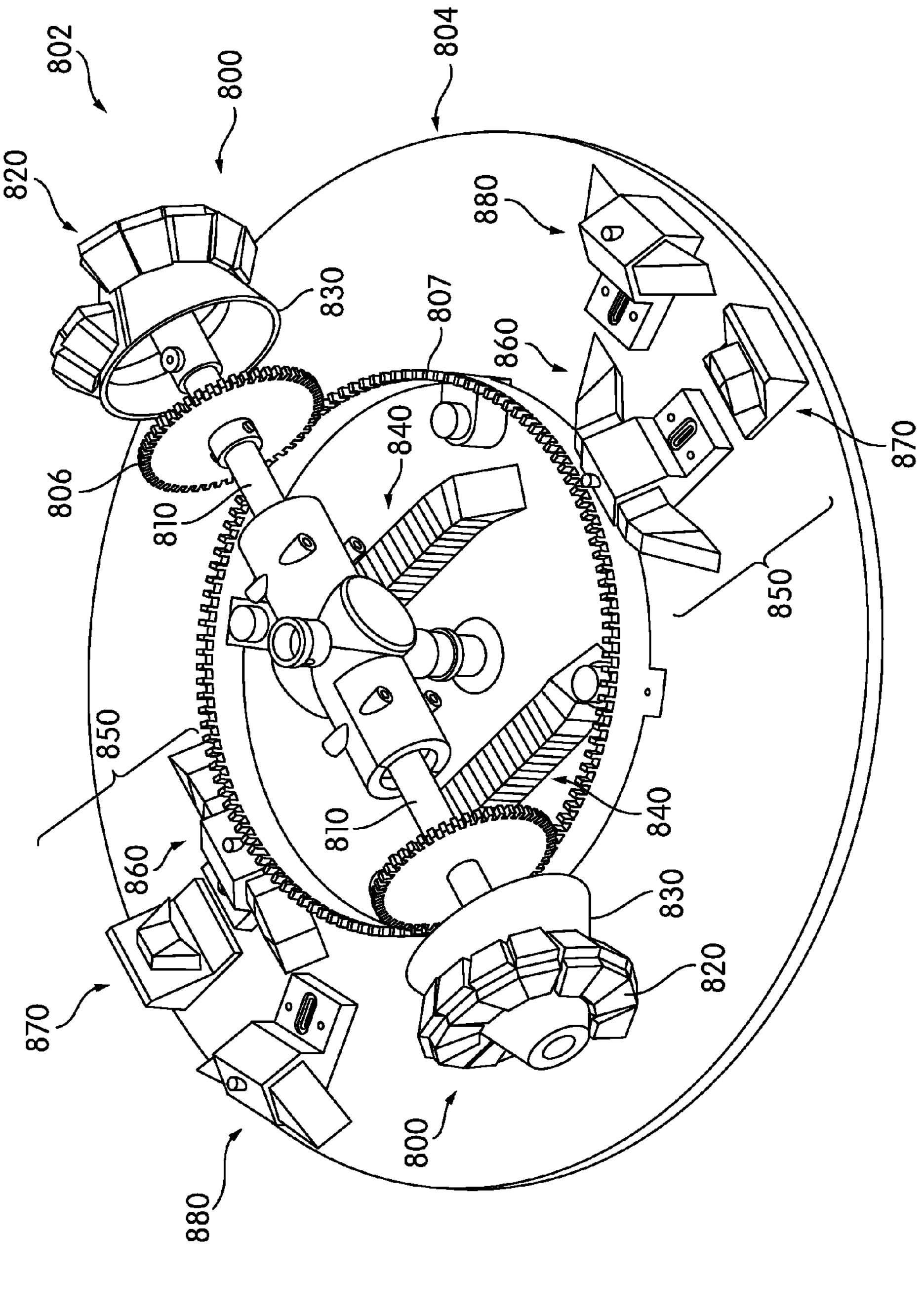

802
800
804
820
880
830
807
860
840
806
870
810
850
850
840
810
860
830
820
870
800
880

FIG. 8

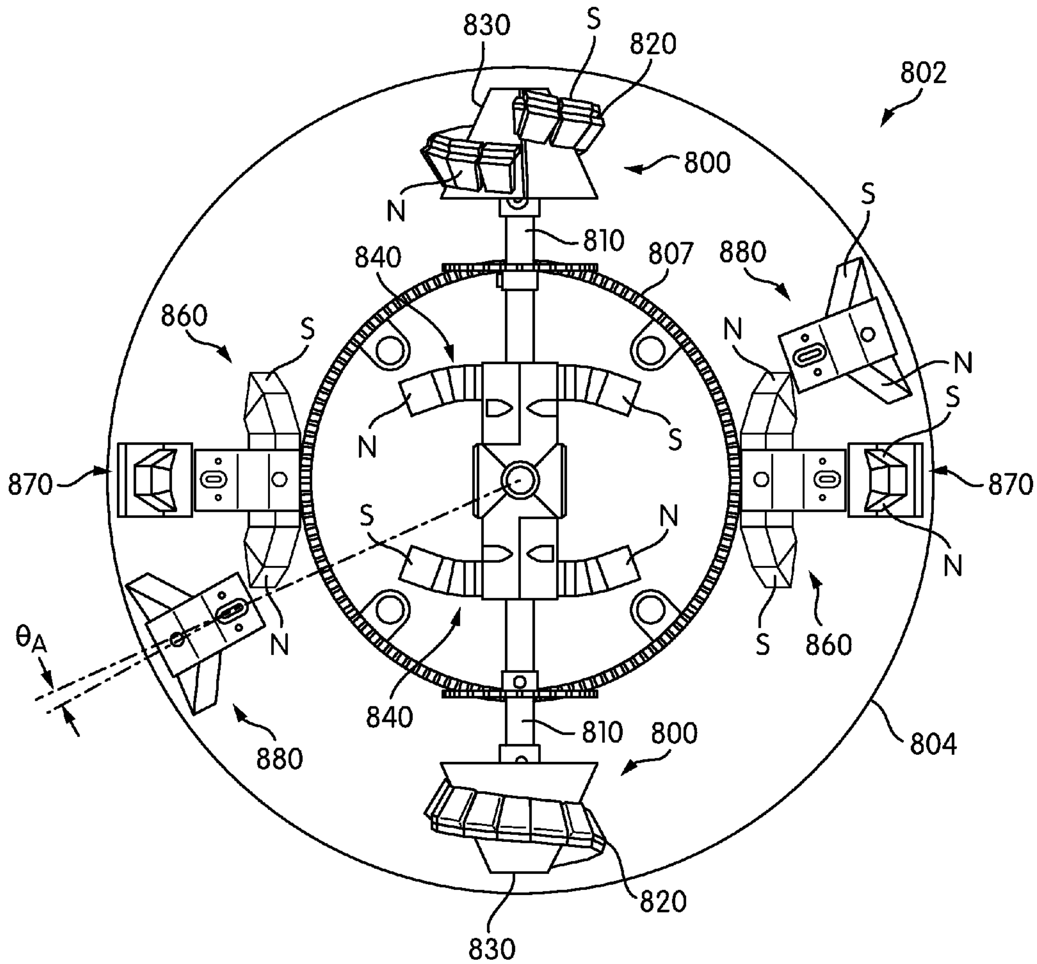

830
S
820
802
800
N
810
807
880
840
S
860
S
N
N
N
S
S
870
870
S
N
N
N
θA
N
S
860
840
880
810
800
804
820
830

FIG. 9

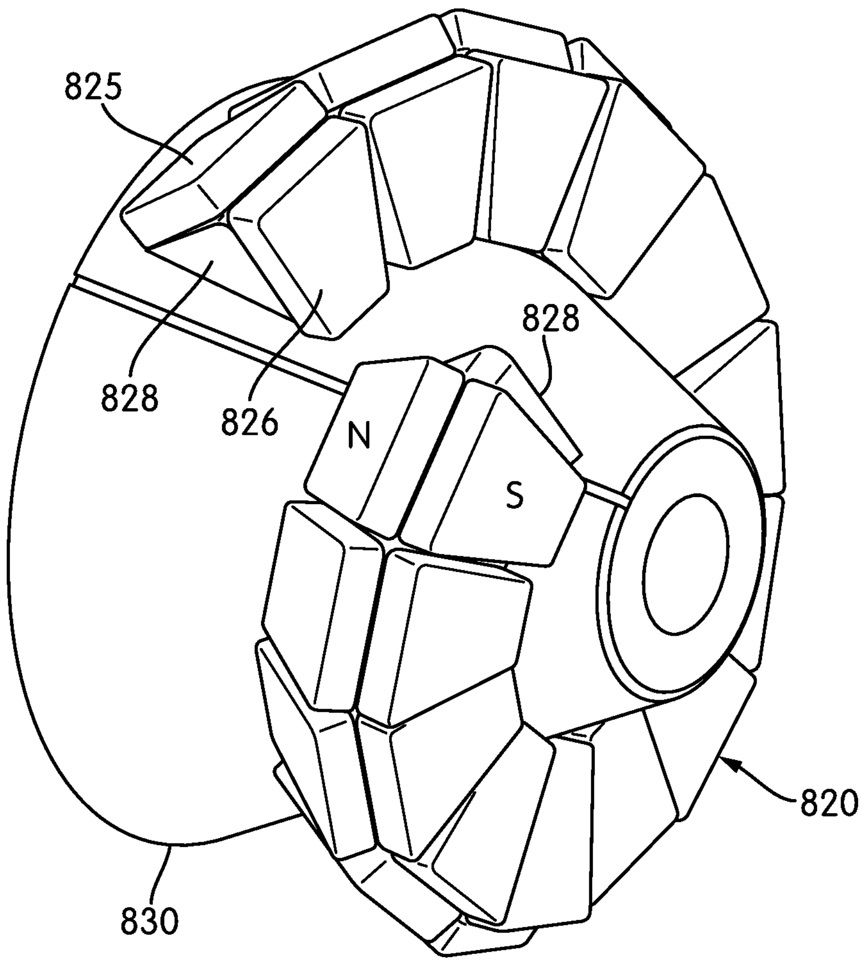



FIG. 10

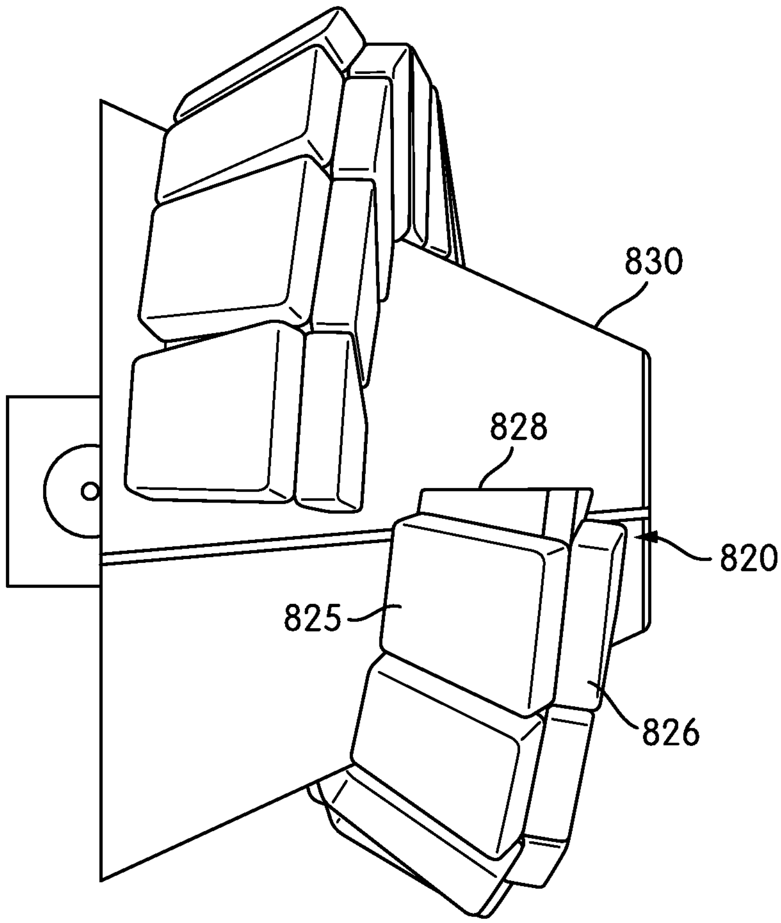



FIG. 11

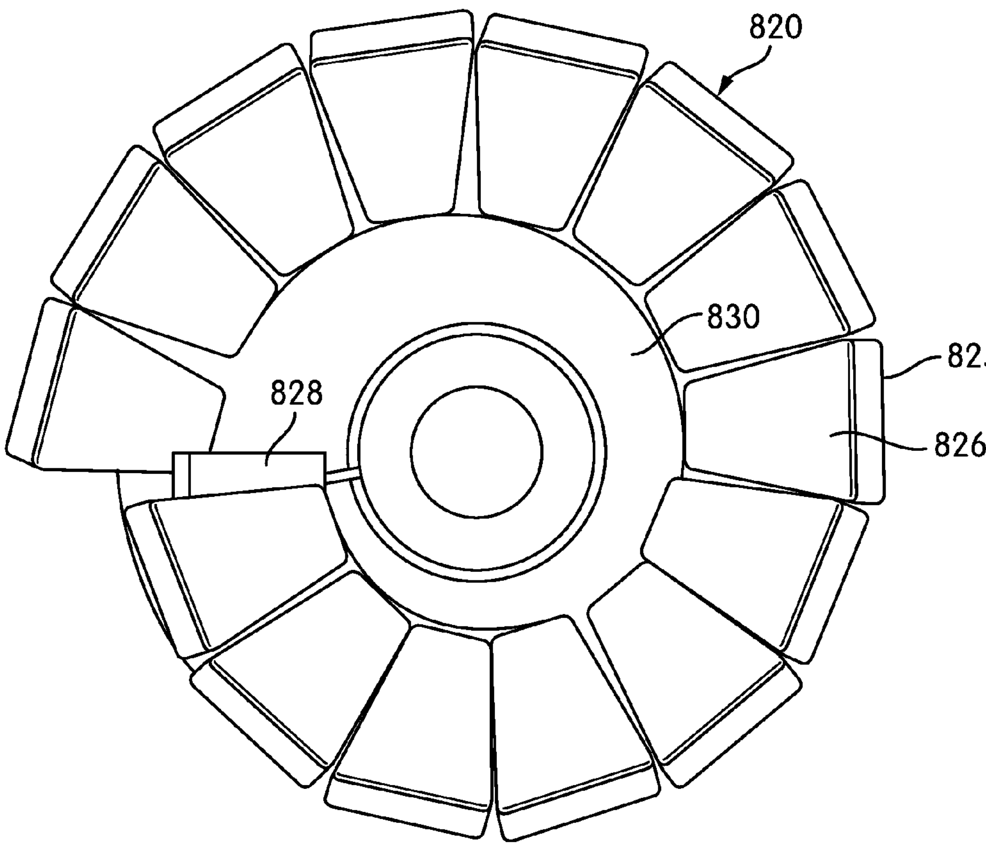



FIG. 12

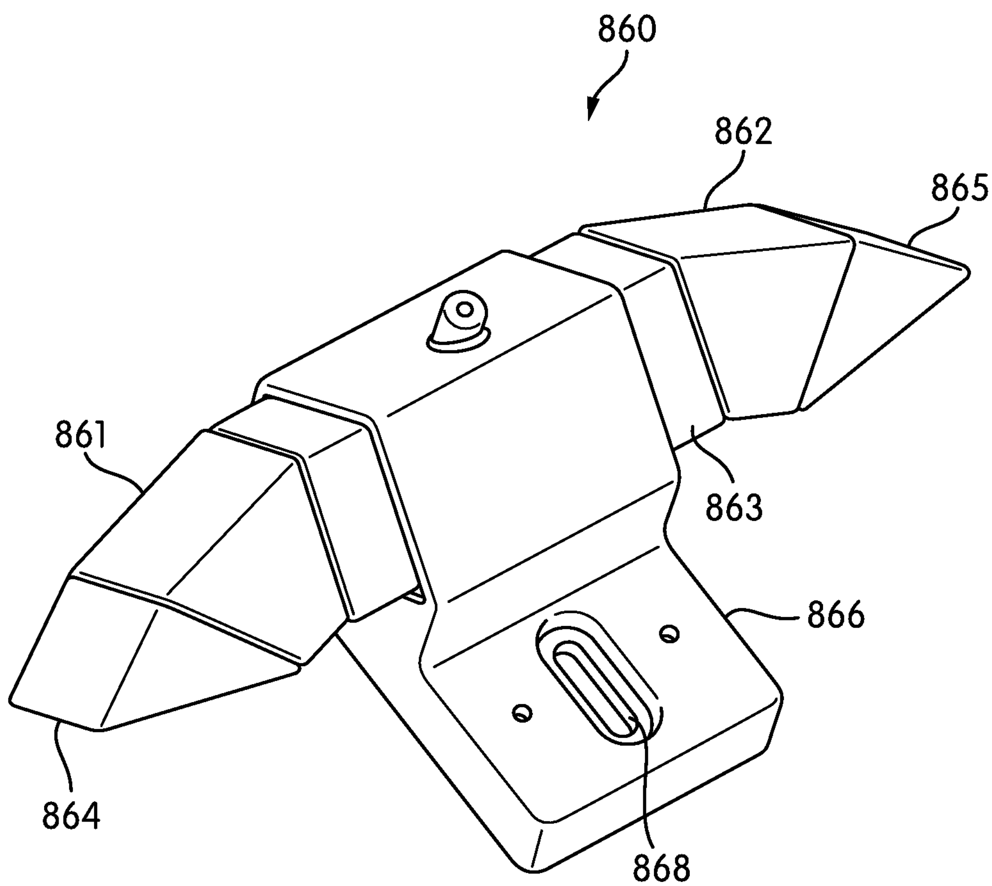



FIG. 13

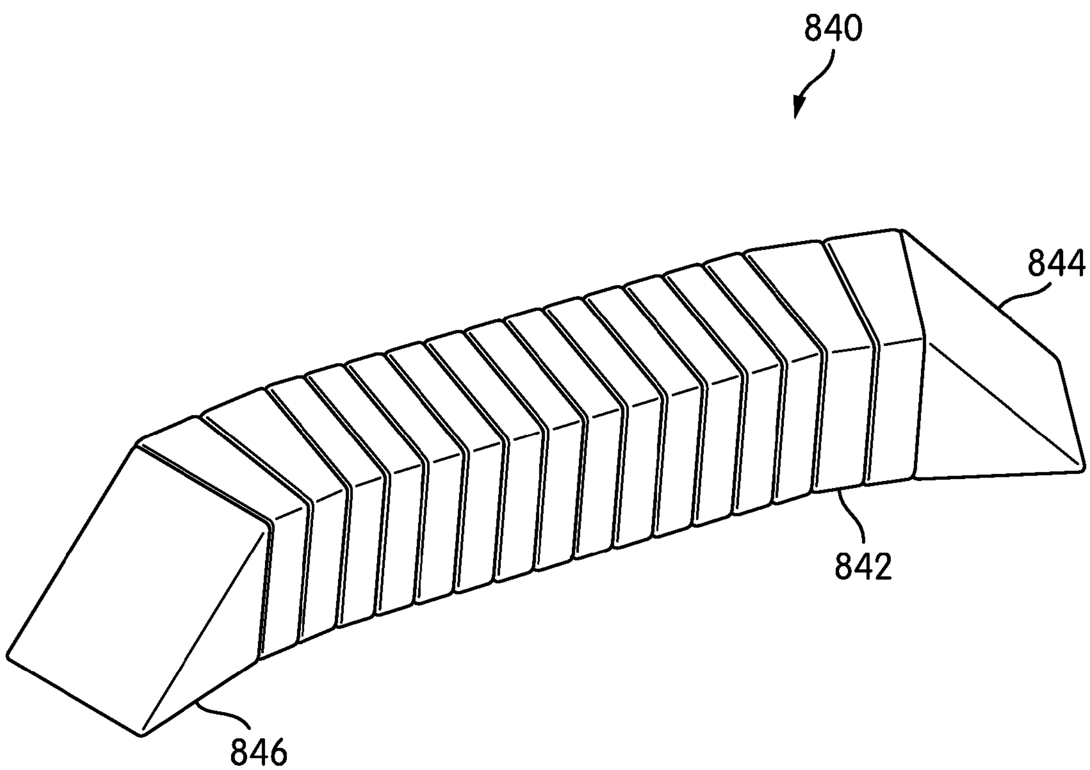



FIG. 14

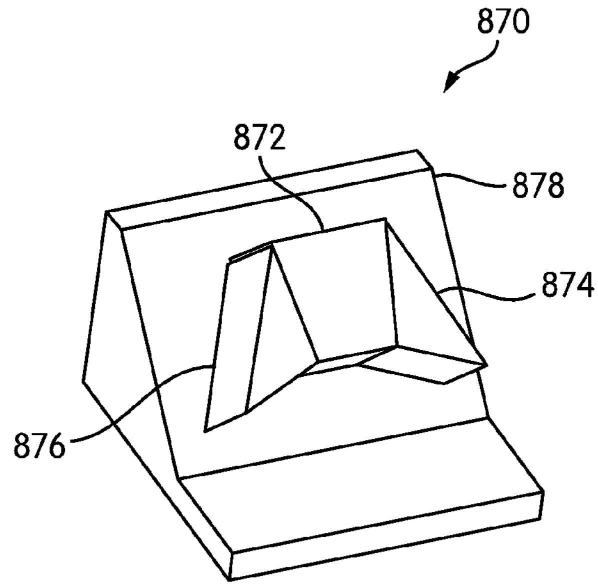



FIG. 15

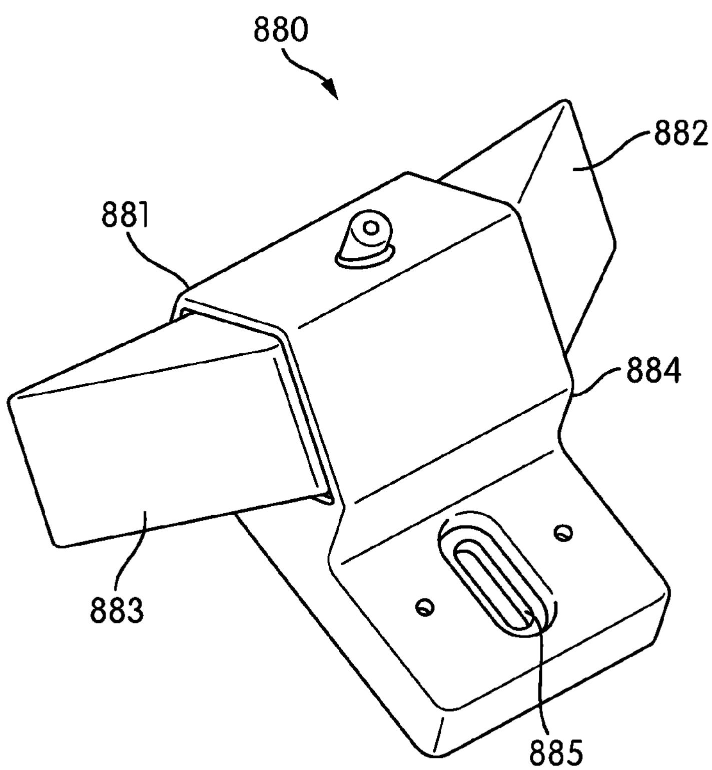



FIG. 16

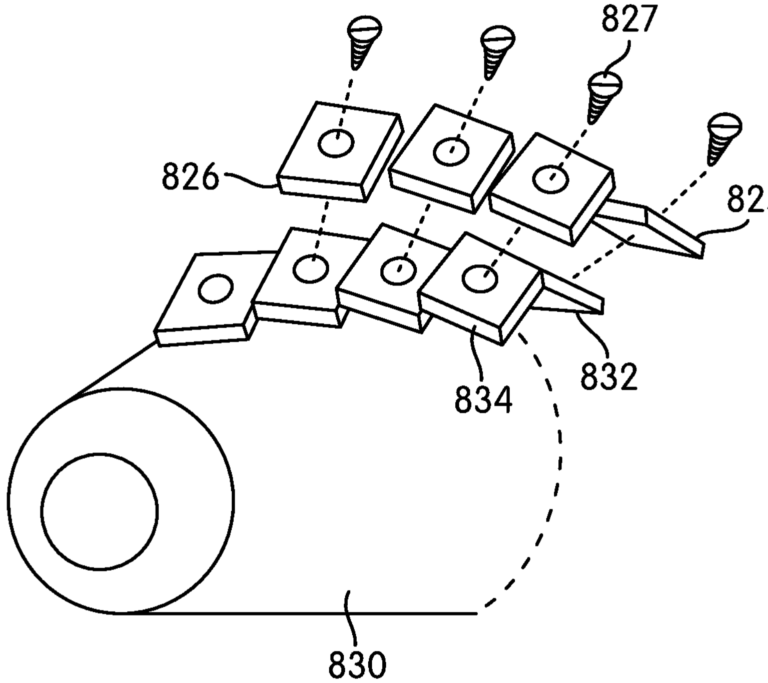



FIG. 17

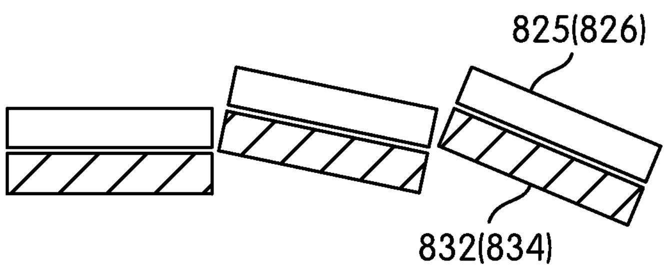



FIG. 18

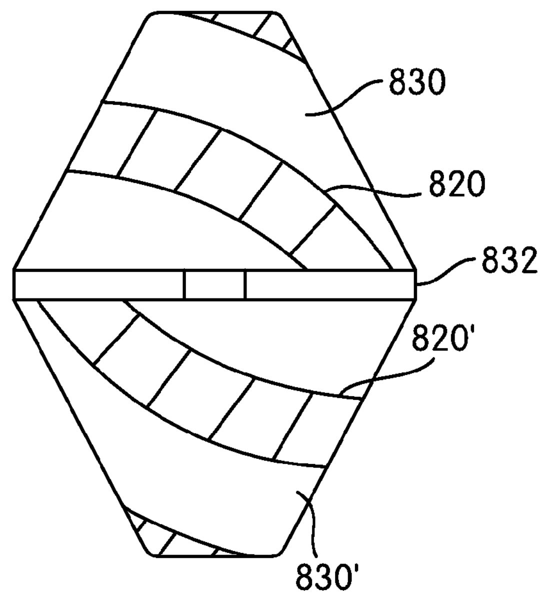



FIG. 19

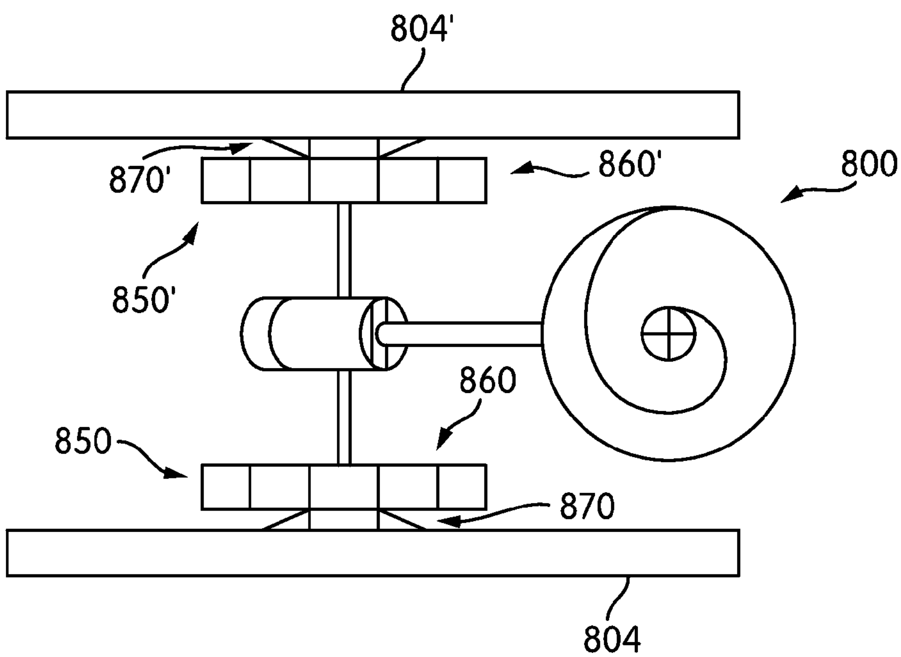



FIG. 20

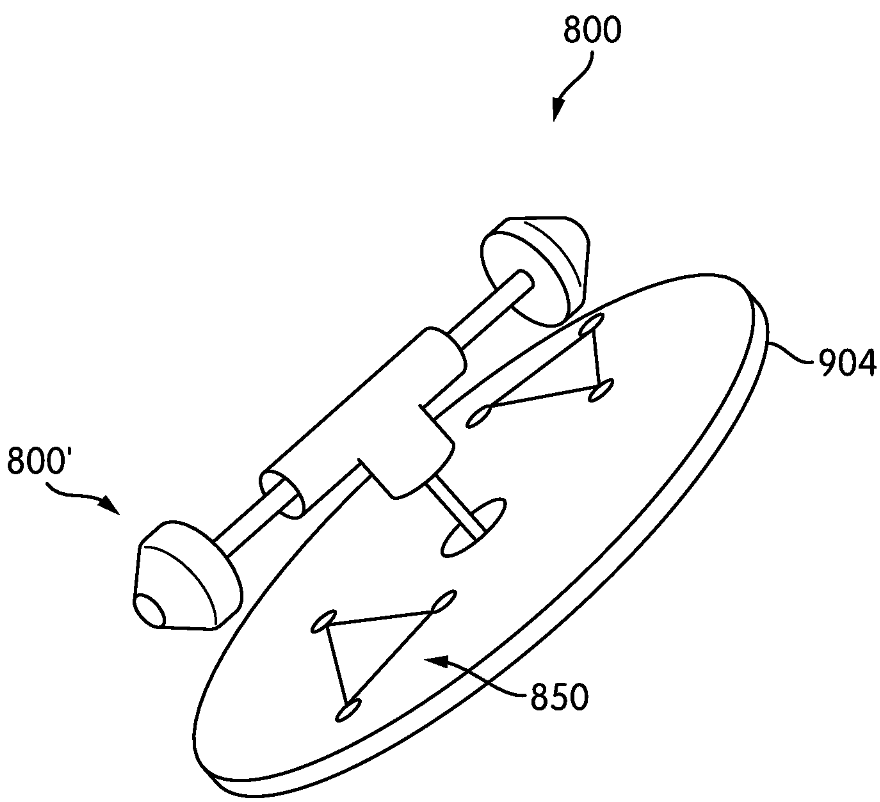



FIG. 21

# DEVICES AND METHODS FOR MECHANICALLY COUPLING MAGNETIC FIELD INDUCED MOTION

## PRIORITY CLAIM

This application claims the benefit under 35 U.S.C. §119 (e) of U.S. Provisional Application No. 61/713,129 filed Oct. 12, 2012, the disclosure of which is hereby incorporated by reference in its entirety.

## BACKGROUND

1. Field of the Invention

The present invention relates to devices and structures for mechanically coupling forces induced by interacting magnetic fields into motive forces which may be coupled to a generator or other load. The present invention further relates to magnetic coupling units having particular dynamic arrangements.

2. Discussion of Related Art

It is recognized in the art that magnets interact with attractive and repulsive forces and that these forces can be used to perform useful work. Such work may include rotation of a shaft and linear movement of a mass. Magnetic motors illustrating this principle are disclosed, for example, in U.S. Pat. Nos. 6,274,959, 4,598,221, 4,196,365, and 4,179,633.

A driving apparatus disclosed in U.S. Pat. No. 6,274,959 has a rotatable disk with a magnet alley and an arrangement of peripheral permanent magnets. A reciprocal device also has a magnet alley that includes reciprocating permanent magnets which interact with the peripheral permanent magnets. Each reciprocating magnet is movable between two positions to attract and repel a peripheral permanent magnet as it rotates in proximity to the reciprocating magnet.

U.S. Pat. No. 4,598,221 discloses a permanent magnet motion conversion device having a ring stator with stator magnets aligned along its circumference and a rotor with permanent magnets. The rotor magnets rock about an axis as the rotor turns.

U.S. Pat. No. 4,196,365 discloses a magnetic motor having a shaft mounted rotating disc on which are mounted three permanent magnets oriented and spaced radially. A stationary bracket has two permanent magnets mounted in proximity to the disc such that the magnetic fields of the bracket magnets and the rotor magnets can interact. The bracket is attached to a reciprocating device which changes the distance of the bracket magnets to the rotor in relation to the rotation of the rotor.

U.S. Pat. No. 4,179,633 discloses a permanent magnet wheel drive having a flat wheel containing peripherally mounted identical magnet segments and a concentric magnetic driving device having multiple pairs of identical magnet segments mounted on rockers.

Common to each of these prior art patents are elements which mechanically reciprocate or rock in an attempt to change the orientation of a magnetic field or to block or allow extension of a magnetic field so as to achieve productive magnetic field interactions and avoid unproductive magnetic field interactions. Such mechanically reciprocating and rocking elements create inefficiencies, reducing the amount of work which may be performed. Moreover, such elements increase the complexity of the devices, leading to high expense in their construction and maintenance. Such complexity also means that the devices are not effectively scalable, i.e., it is not effective to combine a multiplicity of



such devices to perform greater amounts of work. Thus, it is a goal of the present invention to overcome the above stated disadvantages.

## SUMMARY OF THE INVENTION

Aspects of the invention are embodied in an apparatus for coupling magnetic forces into motive force, the apparatus comprising a spinner arm and a magnetic power bed. The spinner arm comprises a helical array of magnets having a helical axis, a spinner arm shaft onto which the helical array of magnets is mounted, wherein the spinner arm shaft has a longitudinal axis that is coincident with the helical axis and wherein the spinner arm shaft is mounted so as to be rotatable about a first axis of rotation coinciding with its longitudinal axis and to be rotatable about a second axis of rotation that is transverse to the longitudinal axis. The magnetic power bed comprises a first magnetic boost element and a second magnetic boost element. The first and second magnetic boost elements are positioned with respect to the spinner arm such that at least a portion of the helical array of magnets will pass between the first and second magnetic boost elements as the spinner arm rotates about the second axis of rotation. The helical array of magnets and the first and second magnetic boost elements are cooperatively arranged so that magnetic interaction between the helical array of magnets and the first and second magnetic boost elements causes the spinner arm and the helical array of magnets to rotate about the first axis of rotation as at least a portion of the helical array of magnets passes between the first and second magnetic boost elements. The first and second magnetic boost elements define a tri-field arrangement of magnetic flux whereby the first magnetic boost element comprises two magnetic blocks separated by a magnetically-responsive material and the second magnetic boost element comprises a single magnetic block.

According to further aspects of the invention the first magnetic boost element comprises a crescent shaped magnet array including a first arc-shaped magnetic block and a second arc-shaped magnetic block with a steel bar disposed between the first and second arc-shaped magnetic blocks.

According to further aspects of the invention the crescent shaped magnet array further comprises a first steel shunt element disposed on an end of the first arc-shaped magnetic block opposite the steel bar and a second steel shunt element disposed on an end of the second arc-shaped magnetic block opposite the steel bar. The shunts may be wedge shaped.

The first and second arc-shaped magnetic blocks may each comprises a single integral magnet and may comprise Neodymium.

According to further aspects of the invention, the second magnetic boost element comprises a booster field magnet comprising a single magnetic block.

The magnetic block of the booster field magnet may comprise a single, integral magnet and may comprise Neodymium.

According to further aspects of the invention, the booster field magnet further comprises steel shunt elements located on opposite ends of the magnetic block. The steel shunt elements may be wedge shaped.

According to further aspects of the invention, the auxiliary magnet array comprises a single magnetic block.

The magnetic block of the auxiliary magnet array may comprises a single, integral magnet and may comprise Neodymium.

According to further aspects of the invention, the auxiliary magnet array further comprises steel shunt elements located on opposite ends of the magnetic block. The steel shunt elements may be wedge shaped.

According to further aspects of the invention, the apparatus further comprises a secondary magnetic power bed axially displaced from the magnetic power bed with respect to the second axis of rotation. The secondary magnetic power bed comprises a first magnetic boost element and a second magnetic boost element. The first and second magnetic boost elements of the secondary magnetic power bed are positioned with respect to the spinner arm such that at least a portion of the helical array of magnets will pass between the first and second magnetic boost elements of the secondary magnetic power bed as the spinner arm rotates about the second axis of rotation. The helical array of magnets and the first and second magnetic boost elements of the secondary magnetic power bed are cooperatively arranged so that magnetic interaction between the helical array of magnets and the first and second magnetic boost elements of the secondary magnetic power bed causes the spinner arm and the helical array of magnets to rotate about the first axis of rotation as at least a portion of the helical array of magnets passes between the first and second magnetic boost elements of the secondary magnetic power bed. The first and second magnetic boost elements of the secondary magnetic power bed define a tri-field arrangement of magnetic flux whereby the first magnetic boost element comprises two magnetic blocks separated by a magnetically-responsive material and the second magnetic boost element comprises a single magnetic block.

According to further aspects of the invention, the helical array of magnets comprises a first row of magnets and a second row of magnets, both extending along a helical path.

According to further aspects of the invention, each of the magnets of the first row of magnets is arranged at an angle with respect to each of the magnets of the second row of magnets.

The magnets of the first and second rows of magnets may be mounted on a helical mounting backing.

According to further aspects of the invention, the apparatus of claim further comprises a hub within which the spinner arm shaft is mounted and configured to allow rotation of the spinner arm shaft about the first axis of rotation.

According to further aspects of the invention, the apparatus of claim further comprises a stator plate on which the magnetic power bed is mounted; and a shaft extending perpendicularly from the stator plate and having a longitudinal axis coincident with the second axis of rotation. The hub is coupled to the perpendicular shaft so as to be rotatable about the second axis of rotation.

According to further aspects of the invention, the pole face of each magnet of the helical array of magnets is parallel to a pole face of a magnetic block of the first or second magnetic boost element during at least a portion of the time the helical array of magnets is passing between the first and second magnetic boost elements.

According to further aspects of the invention, the apparatus includes a second spinner arm and a second magnetic power bed.

According to further aspects of the invention, the apparatus further comprises a shunt bridge extending between the first and second magnetic power beds and configured to provide a pathway for magnetic flux to flow from the first magnetic power bed to the second magnetic power bed.

According to further aspects of the invention, the shunt bridge comprises a plurality of magnets arranged side-by-side with alternating polarities.

According to further aspects of the invention, the shunt bridge further comprises a steel shunt element located at each opposite end of the shunt bridge.

According to further aspects of the invention, the apparatus comprises two shunt bridges extending between the first and second magnetic power beds and disposed on diametrically opposed sides of the second axis of rotation.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an exemplary arrangement of magnets in accordance with an aspect of the present invention.

FIGS. **2**A-**2**C illustrate a relationship between a spinner arm translational position and helical array angular position in accordance with an aspect of the present invention.

FIGS. **3**A-**3**D illustrate embodiments of a tapered helical array of magnets in accordance with an aspect of the present invention.

FIGS. **4**A-**4**E illustrate embodiments of power bed magnet arrays in accordance with an aspect of the present invention.

FIG. **5** illustrates a stator plate assembly in accordance with an aspect of the present invention.

FIG. **6** illustrates a tower-type assembly of stator plate assemblies.

FIG. **7** illustrates a linear assembly in accordance with an aspect of the present invention

FIG. **8** is a top perspective view of a stator plate assembly embodying aspects of an alternate embodiment of the invention.

FIG. **9** is a top plan view of the stator plate assembly of FIG. **8**.

FIG. **10** is a perspective view of a spinner cone with a helical magnet array embodying aspects of an alternative embodiment of the invention.

FIG. **11** is a side view of the spinner cone and helical magnet array of FIG. **10**.

FIG. **12** is an end view of the spinner cone and the helical magnet array of FIG. **10**.

FIG. **13** is a perspective view of a crescent-shaped magnet array of an alternate embodiment of the invention.

FIG. **14** is a perspective view of a shunt bridge of an alternate embodiment of the invention.

FIG. **15** is a perspective view of a booster field magnet.

FIG. **16** is a perspective view of an auxiliary power bed.

FIG. **17** is a perspective view of a spinner cone with a helical array of two rows of overlapping magnets.

FIG. **18** is a side view detail of overlapping magnets.

FIG. **19** is a side view of a spinner cone configuration comprising dual cones joined end to end.

FIG. **20** is a schematic view of a stator plate assembly include two stator plates.

FIG. **21** is perspective view of an apparatus for coupling magnetically induced motion comprising a static spinner cone and a rotating base plate.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Unless defined otherwise, all terms of art, notations and other technical terms or terminology used herein have the same meaning as is commonly understood by one of ordinary skill in the art to which this disclosure belongs. If a definition set forth in this section is contrary to or otherwise inconsistent with a definition set forth in the patents, applications, published applications, and other publications that are herein incorporated by reference, the definition set forth in this section prevails over the definition that is incorporated herein by reference.

The use of the terms "a" and "an" and "the" and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The terms "comprising," "having," "including," and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to,") unless otherwise noted. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. For example, if the range 10-15 is disclosed, then 11, 12, 13, and 14 are also disclosed. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention.

This description may use relative spatial and/or orientation terms in describing the position and/or orientation of a component, apparatus, location, feature, or a portion thereof. Unless specifically stated, or otherwise dictated by the context of the description, such terms, including, without limitation, top, bottom, above, below, under, on top of, upper, lower, left of, right of, in front of, behind, next to, adjacent, between, horizontal, vertical, diagonal, longitudinal, transverse, etc., are used for convenience in referring to such component, apparatus, location, feature, or a portion thereof in the drawings and are not intended to be limiting.

Furthermore, unless otherwise stated, and specific dimensions mentioned in this description are merely representative of an exemplary implantation of a device embodying aspects of the invention and are not intended to be limiting.

With reference to FIG. **1**, a spinner arm **100** and power bed **150** are illustrated in accordance with one embodiment of the invention. Spinner arm **100** is constructed to spin about an axis A**10** defined by shaft **110** in direction DR**10**. Spinner arm **100** includes a tapered helical array **120** of spinner magnets **125**. Tapered helical array **120** may comprise substantially a single revolution around the spinner arm axis and may be mounted on a support structure such as cone **130**. Spinner arm **100** may further include bearings **140** and pinion gear **145**. FIG. **1** further illustrates a power bed **150**. In one embodiment, this power bed **150** may include two arrays of magnets, inner array **160** and outer array **170**. In other embodiments, power bed **150** may include one magnet array or more than two magnet arrays.

In one embodiment, shaft **110** is cylindrically shaped and constructed of non-ferrous material, preferably aluminum, with a standard stock diameter readily available from suppliers. In a preferred embodiment, shaft **110** is black oxide plated, preventing pitting and oxidation. Bearings **140** may be made of stainless steel and in sizes readily available from suppliers.

Spinner arm **100** and power bed **150** are mounted relative to each other such that spinner arm **100** is able to move in translational direction DT**10** while power bed **150** is relatively fixed. The spinner magnets **125** in tapered helical array **120** and the magnets in power bed **150** interact to induce spinner arm **100** to move in translational direction DT**10**. At the same time, spinner arm **100** and power bed **150** are mounted relative to each other such that shaft **110** rotates in direction DR**10** about axis A**10** as the entire spinner arm **100** assembly moves in translational direction DT**10**. For reference, reference point RP is shown in FIG. **1** on the apex of cone **130**, indicating a relative angular orientation of tapered helical array **120** of 0° about axis A**10**.

FIGS. **2**A-C illustrate, with corresponding plan and elevation views, the approximate angular orientations of tapered helical array **120** as spinner arm **100** approaches, transits, and exits power bed **150**, for one embodiment. In this embodiment, as illustrated in FIG. **2**A, spinner arm **100** moves translationally in direction DT**10** relative to power bed **150** and tapered helical array **120** has a relative angular orientation of approximately −22° as it becomes proximal to power bed **150**. As spinner arm **100** continues to move translationally in direction DT**10**, transiting through power bed **150**, it is rotating in direction DR**10**, advancing the angular orientation of tapered helical array **120** to approximately 180° at a mid-transit point as illustrated in FIG. **2**B. As the rotation and translation of spinner arm **100** continues and it exits power bed **150**, the angular orientation of tapered helical array **120** is approximately 22° as illustrated in FIG. **2**C.

As illustrated in FIG. **3**A, tapered helical array **120** is comprised of spinner magnets **125** mounted on cone **130**. In one exemplary embodiment, cone **130** may be in the shape of a right circular cone with a truncated apex **135**. Cone **130** may be composed of a non-magnetic, non-conductive material such as molded thermoplastic. Plastics such as PVC, polycarbonate, thermoplastic resins, and acrylics are preferred. Spinner magnets **125** are preferably rare earth magnets having similar high power flux and high coercive force to the magnets in power bed **150** (further described below). Magnets made of neodymium iron boron (NdFeB), samarium cobalt (SmCo), or ferrites are preferred. In exemplary embodiments, 45 MGOe NdFeB magnets or 28 MGOe SmCo magnets may be used.

Each magnet **125** may be affixed to cone **130** using a high strength industrial adhesive such as Loctite. Other methods, such as through-hole screws and brackets, may be used alone or in combination with each other and/or with the use of an adhesive. FIG. **3**B illustrates an exemplary embodiment in which bracket **310** is mounted on cone **130** along the path of tapered helical array **120**. Cone **130** may have an optional milled or molded base structure **320**. Magnet **125**H may be inserted in to bracket **310**. Additionally, or independently, magnet **125**H may include a counter sunk through-hole **330** through which flat head screw **340** may be inserted, fastening magnet **125**H to cone **130** through cone through-hole **350**. In one embodiment, flat head screw **340** is steel. In another embodiment, a flat head steel pop rivet may be substituted for flat head screw **340**.

Spinner magnets **125** may be cuboid in shape, having relative height, width, and depth of approximately 1, 1, and 0.25, respectively. In another embodiment, the magnets are rectangular in shape and have a taper running along the length through the thickness of the magnet dimension, the taper having, for example, a 2-1 ratio. In one embodiment, spinner magnets **125** are polarized such that the magnetic poles are perpendicular to the large faces. In one embodiment, spinner magnets **125** are mounted on cone **130** with their south poles oriented outward and directed away from cone **130**. In another embodiment, the large faces of spinner magnets **125** are isosceles trapezoids having a narrower end

325T and broader end 325B and are mounted with narrower end 325T oriented in the direction of apex **135**, as illustrated in FIG. **3**A. Spinner magnets **125** are mounted to cone **130** such that tapered helical array **120** is formed. In one exemplary embodiment, tapered helical array **120** comprises approximately 1 revolution around cone **130** and may have a pitch (i.e., spacing of successive revolutions relative to the axis) of approximately the height of one magnet as in, for example, magnet height **380**. In another embodiment the pitch is as much as eight. Tapered helical array **120** is tapered, i.e., its radial distance from its axis is a linear function of its position along the axis, such that it may follow the contour of cone **130**.

In a preferred embodiment, as illustrated in FIG. **3**C, the spinner magnets **125** of tapered helical array **120** are mounted in an overlapping fashion with approximately 2-5% of the magnet faces overlapped. In this embodiment, as in the arrangement shown in FIG. **3**A, the large faces of spinner magnets **125** may be trapezoidal. However, the large width of the trapezoid is oriented in the direction of apex **135**. Tapered helical array **120** may be assembled by placing a first spinner magnet **125-1** at the apex **135**, lapping a leading edge of second spinner magnet **125-2** on the trailing edge of spinner magnet **125-1**, lapping a leading edge of third spinner magnet **125-3** on the trailing edge of spinner magnet **125-2**, and so on, following the path of a tapered helix to the base of cone **130**. Alternatively (not shown), a first spinner magnet may placed at the base of the cone, followed by lapping a trailing edge of a second spinner magnet on the leading edge of the first spinner magnet, followed by lapping a trailing edge of a third spinner magnet on the leading edge of the second spinner magnet, and so on, following the path of a tapered helix to the apex **135**.

As illustrated in FIG. **3**D, depicting cross section D-D of FIG. **3**A through the axis of the cone **130**, a cross sectional edge of cone **130** forms angle $\theta_C$ with the axis of cone **130** and spinner magnets **125** form angle $\theta_M$ with the axis of cone **130**. In a preferred embodiment $\theta_M$ is constant along the length of tapered helical array **120**, may be up to 60°, and is most preferably approximately 45°. Angle $\theta_C$ is generally equal to or smaller than $\theta_M$.

In other aspects, spinner magnets **125** may be attached to spinner shaft **110** via a support structure other than cone **130**. For example, spinner magnets **125** can be mounted on a series of supports emanating radially (not shown) from spinner shaft **110**.

As illustrated in FIG. **4**A, power bed **150** is comprised of two arrays of magnets: inner array **160** and outer array **170**. In one exemplary embodiment, inner array **160** consists of 6 power bed magnets **480** and outer array **170** consists of 12 power bed magnets **480**. In other embodiments inner array **160** may have 3-25 magnets and outer array **170** may have 6-50 magnets. Power bed magnets **480** may be cuboid in shape and have relative dimensions of 1, 1, and 0.25. In other embodiments (not shown), power bed magnets **480** may be triangular, trapezoidal (similar to magnets **125** illustrated in FIG. **3**A), or arc segments having a taper running across the width. Power bed magnets **480** are preferably rare earth, including NdFeB, SmCo and hard ferrites of grades C **5** and C **8**, and have high power flux and high coercivity. Their magnet poles are preferably oriented perpendicularly to their large faces. In preferred embodiments of each array, inner array **160** and outer array **170**, the poles of power bed magnets **480** are oriented in a common direction and typically substantially parallel to DT**10**; when the leading end **410** of outer array **170** is north in polarity, the leading end **430** of inner array **160** is south in polarity.

Power bed **150** optionally comprises power bed housing **490**, which encapsulates power bed magnets **480** in a non-magnetic, non-ferrous, and non-conductive material. Suitable materials include PVC, polycarbonate, thermoplastic resins, and acrylics.

In one embodiment, the power bed magnets **480** in outer array **170** may be oriented to have angle $\theta_A$ so as to create an array face which would be substantially parallel to tapered helical array **120**, as illustrated in FIG. **4**A. In a preferred embodiment, power bed magnets **480** in inner array **160** are oriented such that $\theta_B$ is approximately the same as $\theta_A$. In one embodiment, inner array **160** and outer array **170** are oriented substantially in parallel with the direction of travel DT**10** of spinner arm **100**. In another embodiment, outer array **170** is angled with angle $\theta_O$ such that leading end **410** is closer to inner array **160** than trailing end **420**. In a preferred embodiment, angle $\theta_O$ may be approximately 10-15°.

In alternative embodiments of outer array **170**, the power bed magnets **480** may be arranged as stepped magnet arrays such as stepped array **450**, as illustrated in FIG. **4**B or angled magnet arrays such as angled array **460**, as illustrated in FIG. **4**C. These alternative embodiments allow the magnetic flux to be gradually increased in height and/or strength from one end to a peak in the center of the array and then decreased from the center to the other end. In another embodiment illustrated in FIG. **4**E, shunt blocks **495** are added on each side of the array. Shunt blocks **495** may be employed to shunt flux leakage and may be steel blocks, i.e., a non-magnetic, but magnetically responsive material.

As illustrated in FIG. **4**D, the poles of power bed magnets **480** are oriented to provide alternating north and south polarities, creating a narrow flux path on each power bed magnet **480**, having a maximum concentration of flux lines on each magnet and narrow peaks with sharp bands. The stepped array **450** (illustrated in FIG. **4**B) and angled array **460** (illustrated in FIG. **4**C) create a lower flux path at the leading and trailing ends of the arrays. In these preferred embodiments, the power bed **150** creates a specific flux path that smoothes the entry of and decreases the entry resistance to spinner arm **100** on leading end **420** and repels the spinner arm on the trailing end **410** as the spinner arm **100** rotates in the clockwise rotation about its axis.

In other embodiments, the power bed magnets **480** may be mounted on a low carbon steel plate **475** to increase magnetic flux at the top of the array, as illustrated in FIG. **4**D. Low carbon steel plate **475** may be sized to match an array's footprint and mated to an inner and/or outer array of magnets such as, for example, stepped array **450** or angled array **460**.

Power bed **150** may be mounted on a substrate (not shown) with non-magnetic type fasteners (not shown) such as stainless steel or brass screws instead of non-magnetic rivets. Screws are preferred because they permit easy assembly and disassembly as well as ease of alignment of a power bed **150** on a substrate.

In accordance with one configuration of an embodiment of the invention, the spinner arm **100** is initially not moving relative to the power bed **150**. An initial external force, not shown, is applied to the spinner arm **100** so that it moves in the translational direction towards power bed **150**, overcoming any repelling interaction between the spinner arm and power bed **150**. Spinner arm **100** rotates about its axis as it moves in relation to power bed **150**, dynamically reconfiguring the magnetic interaction between spinner arm **100** and power bed **150**. Once proximal to power bed **150**, a repelling force pushes spinner arm **100** away from power bed **150** in the translational direction, the repelling force being greater than the initial force.

In accordance with scaled embodiments of the invention, pluralities of spinner arms **100** and power beds **150** may be assembled into structures which scale-up and couple the translational movement of the multiple spinner arms into linear or rotational movement of a load.

FIG. **5** illustrates one such scaled embodiment of the invention comprising a stator plate assembly **500** that includes a substrate or stator plate **520** to which multiple power beds **150** are fastened. In this exemplary embodiment, a pinion rack **530** is affixed to the stator plate **520** on which ride the pinion gears **145** of each spinner arm **100**. Spinner arm **100** is also coupled in hub **540** via bearings **140** (see FIG. **1**) so that the spinner arm may rotate about its axis. In the embodiment illustrated in FIG. **5**, 4 power beds **150** are affixed to stator plate **520** and 4 spinner arms **100** are coupled to hub **540**. The power beds **150** define a circular power track **550** with power beds **150** spaced approximately 90° apart. The hub **540** defines four axes about which spinner arms **100** may rotate; the axes lie in a plane parallel to a plane defined by stator plate **520**. As shown in FIG. **5**, the axes may be spaced 90° apart. Hub **540** is affixed to stator shaft **510** such that the rotation of hub **540** about the axis defined by stator shaft **510** causes stator shaft **510** to rotate.

Hub **540** may optionally be made in the shape of a cube with bores on each side to accommodate bearings for each spinner arm **100**. Hub **540** may be constructed of non-magnetic, non-ferrous materials such as molded plastics, brass, stainless steel Austenitic types, for example, types **304** or **316**, or aluminum. In a preferred embodiment, hub **540** is constructed of aluminum having oxide plating, providing easy machining, cost effectiveness, light weight, lower labor costs and non-oxidation.

The operation of this exemplary embodiment depicted in FIG. **5** is described as follows. In one configuration, spinner arms **100** are positioned an initial distance from corresponding power beds **150**. An initial external force is applied to the system such that tapered helical array **120** and spinner arms **100** are advanced towards power beds **150**, rotating hub **540** and shaft **510** clockwise in direction DR**50**. This rotation of spinner arms **100** around the axis defined by stator shaft **510** moves tapered helical arrays **120** translationally in direction DT**50**. As the hub **540** and spinner arms **100** assembly rotate about the stator shaft **510** axis, spinner arms **100** and shafts **110** are forced to rotate about their axes in direction DR**10** due to the interaction between pinions **145** and rack **530**. The rotation of spinner arm shafts **110** cause tapered helical arrays **120** to be angularly positioned relative to power beds **150** such that a magnetic repulsive force pushes the spinner arms **100** out of the power beds **150**, with each spinner arm moving towards the next power bed in power track **550** such that the similar magnetic interactions occur between the subsequent power bed and the spinner arm. The length of the power beds **150** and the changing orientations of the magnets comprising tapered helical arrays **120** cause spinner arms **100** to experience magnetic forces which, in aggregate, cause the rotation of hub **540** and stator shaft **510** about their axes.

Stator plate **520** is fixed so that stator shaft **510** may be coupled to a generator or other load such as a gear box, wheel, or fan. With the polar orientations of the spinner magnets **125** and array magnets **480** as discussed above, hub **540** tends to rotate in direction DR**50**, causing tapered helical arrays **120** to follow power track **550** in the direction DT**50**. In another embodiment, spinner magnets **125** could have an opposite orientation, tending to have the effect that hub **540** would rotate in a direction opposite to DR**50**.

In other embodiments, a circular configuration such as that shown in FIG. **5** may be modified to accommodate fewer or more power beds in a power track, such as, for example, eight power beds spaced 45° apart or three power beds spaced 120° apart. The circular configuration may further be modified to have fewer or more spinner arms, such as, for example, two spinner arms spaced 180° apart or eight spinner arms spaced 45° apart. In embodiments with fewer power beds, the arrays **160** and **170** of magnets **480** may be comprised of greater numbers of magnets **480** and the pinions **145** and rack **530** are geared such that the spinner arms **100** have fewer rotations about their axes per rotation of hub **540**. In such embodiments, arrays **160** and **170** may approximate the curvature of the power track **550**. In embodiments having greater numbers of power beds, the arrays **160** and **170** of magnets **480** may be comprised of fewer numbers of magnets **480** and the pinions **145** and rack **530** are geared such that the spinner arms **100** have more rotations about their axes per rotation of hub **540**.

Moreover, in other embodiments, the circular configuration of FIG. **5** may be modified to have two or more concentric power tracks. In an exemplary such configuration, spinner arm **100** may be modified to have two tapered helical arrays **120** affixed to a single spinner shaft (not shown) such that one of the two tapered helical arrays interacts with an inner power track and the other with an outer power track. In such a configuration, the number and arrangement of power bed magnets may differ between the inner power track and the outer power track in order to compensate for the differing ratios of spinner rotation to spinner arm translational motion due to the differing circumferences of the power tracks. In another multi-concentric-track embodiment (not shown), coaxial spinners may rotate at different rates and have independent pinion racks. The number of power tracks per each stator plate assembly, the number of power beds per power track, the strength of magnets **480** and **125**, and the number of spinners are among factors determining the torque and power of assembly **500**.

Stator plate **520** may be made of a non-ferrous metal, preferably aluminum. Using aluminum as stator plate **520** prevents induction of the magnetic flux from power beds **150** into stator plate **520**.

Pinion rack **530**, in conjunction with pinion gear **145**, provides for spinner **100** to rotate about its axis at a predetermined rate as the spinner arm **100** moves in a translational direction through a power bed **150**. Pinion gear **145** may optionally be fitted with a set screw and/or shaft key (not shown), permitting the spinner arm **100**, in a maintenance operation, to be rotated about its axis without advancing the spinner arm **100** in a translational direction relative to pinion rack **530**. This allows fine-tuning of initial configurations, including the angular position of the tapered helical array **120** about its axis in relation to its translational displacement relative to a power bed **150**. Such fine-tuning permits an optimal orientation, for example minimizing repulsive forces between the tapered helical array **120** and power bed magnets **480** to permit lower force translational movement of the spinner arm **100** towards the power bed **150** and to translationally push the spinner arm **100** out at the proper point with greater force. The pinion rack to pinion gear ratio may be selected in relation to the number and length of power beds **150** on stator plate assembly **500**.

Additionally, as shown in FIG. **6**, the stator plate assemblies **500** can be stacked on top of each other and coupled to a single stator shaft **610**, further scaling up available torque.

FIG. **7** illustrates another scaled embodiment of the invention. In this embodiment, multiple power beds **150** are spaced along a track **710** defined by rails **720** on which is mounted a car **730**. Spinner arm **740** may be mounted on car **730** so that spinner arm **740** may interact with the power beds **150** spaced along the track. Track **710** also may include one or more racks **750** on which spinner arm pinion **760** may ride. Thus, spinner arm **740** may be configured to rotate and have the desired angular orientation with respect to their displacement from the power beds **150**. In an alternate embodiment, more than one spinner arm **740** may be mounted on car **730**.

Most of the parts are of non-ferrous material and of light weight to reduce the drag/torque and loss of magnetic flux and improve the output of the unit. The use of high power flux magnets helps to keep a unit in operation at an ambient temperature. This in turn reduces the maintenance and increases the output and longevity of the unit.

An alternate embodiment of a stator plate assembly **802** is shown in FIGS. **8** and **9**. The stator plate assembly **802** includes a stator plate **804** two (or more) spinner arms **800**, each including a spinner shaft **810**, a spinner cone **830**, and a helical magnet array **820**. The spinner shafts **810** are mounted within hubs so as to be rotatable about a first axis of rotation coinciding with the longitudinal axes of the shafts. In addition, the hubs are mounted to a center stator shaft extending perpendicularly from the stator plate **804**, so that the spinner shafts **802** are also rotatable with respect to the stator plate **804** about second axis of rotation coinciding with the axis of the perpendicular shaft.

The assembly **802** includes one or more power beds **850**, each comprising a number of magnetic boost elements, such as a crescent shaped magnet array **860**, a booster field magnet **870**, and an auxiliary magnet bed **880**. In the illustrated embodiment, the assembly **802** includes two power beds **850**, and the crescent shaped magnet arrays **860** are located radially inwardly from the booster field magnets **870** and the auxiliary magnet beds **880**, although the relative positions of the crescent shaped magnet arrays **860** and the booster field magnets **870** and the auxiliary magnet beds **880** could be reversed. In addition, the auxiliary magnet bed **880** may be positioned in front of (relative to the rotational direction of the spinner arm **800**) the associated booster field magnet **870**, or the auxiliary magnet bed **880** may be positioned behind the associated booster field magnet **870** depending on the desired interaction between the auxiliary booster magnet **880** and the booster field magnet **870**. In some embodiments, an auxiliary magnet bed **880** may be positioned in front of and behind the booster field magnet **870**.

As described above, a pinion gear **806** is provided on the shaft of each spinner arm **800** and interacts with a pinion rack **807**. The diameter of the gear **806** determines the speed with which the spinner arm **800** rotates and the angular extent of the magnetic boost field applied to the spinner cone **830** as the spinner arm **800** moves through the power bed **850**. The smaller the pinion gear **806**, the faster the spinner arm rotates, but the smaller the angular range of the boost field that is applied to the spinner cone **830** in relation to 360 degree movement around the plate **804**.

Details of the crescent shaped magnet array **860** are shown in FIG. **13**. Each crescent shaped magnet array **860** includes Neodymium Iron Boron (NdFeB) type arc-shaped magnets **861**, **862** with one low carbon type square steel bar **863** (i.e., a non-magnetic, but magnetically responsive material) disposed between the magnets **861**, **862**. Magnets **861**, **862** may each comprise a single magnet or a multiple magnets arranged with attracted polarities. By way of non-limiting example, each magnet **861**, **862** may have an outside radius of 2 inches, an inside radius of 1 inch, a height of 1 inch, and an angular width of 30-60 deg. An exemplary size of the steel bar **863** is 1"×1"×2" long. The purpose of the steel bar **863** between the two arc shaped magnets **861**, **862** is to dampen or reduce the magnetic flux as the spinner arms **800** approach the crescent shape power beds from either direction by shielding the flux between magnets **861**, **862**.

The magnets **861**, **862** may be nickel coated and magnetized along the arc of each magnet with one North Polarity and one South Polarity at opposite ends of each other. The arc magnets **861**, **862** of the crescent shaped power bed **860** are linked with the square steel bar **863** and may optionally include a steel wedges **864**, **865** (wedge shape is optional; rectangular steel blocks may be substituted) on each end of the arc magnets **861**, **862**, respectively. Each crescent shaped magnet array **860** has South-Polarity and North-Polarity opposite of each other crescent shaped magnet array **860** at the tips of the steel wedges **864**, **865**. (See FIG. **9** showing exemplary polarities of the magnetic components for a stator plate assembly **802** configured to rotate the spinner arms in a counterclockwise direction. The polarities would be reversed for a stator plate assembly configured to rotate the spinner arms in a clockwise direction). The purpose of steel wedges **864**, **865** at the ends of the arc magnets **861**, **862** is to taper the magnetic flux pattern to a narrow path (i.e., dampen the magnetic field from magnets **861**, **862** from escaping very far from magnets **861**, **862**) allowing much smoother approach for the spinner arms **800** by reducing the flux field and interaction of like poles between the magnets on the spinner cone **830** and the crescent shaped magnet array **860**. Such interaction of the magnetic fields of the magnets of the spinner cone **830** and the crescent shaped magnet array **860** generates a force repelling movement of the spinner **800** into the power bed **850**. Omitting the wedges **864**, **865** will allow a larger magnetic field around the crescent shaped magnet array **860**. The larger magnetic field will result in an even greater force repelling movement of the spinner **800** into the power bed **850**, but will also result in a greater force rotating the spinner cone **830**. Thus, omitting steel wedges **864**, **865** can result in a greater rotational speed of the spinner cone **830**.

A mounting bracket **866** is provided for attaching the magnet array **860** to the plate **804**. The bracket **866** is preferably configured to hold the magnets **861**, **862**, steel bar **863**, and steel wedges **864**, **865** at a 45 degree orientation with respect to the plate **804**. The mounting bracket **866** is also configured to hold the magnets **861**, **862**, the steel bar **863**, and the steel wedges **864**, **865** at a desired height above the plate **804** so as to be in desired proximity to the spinner cone **830** and the helical magnet array **820** as each spinner arm **800** passes through the power bed **850**. A slotted opening **868**, through which a fastener may be inserted into the plate **804**, allows the position and orientation of the magnet array **860** to be adjusted.

As noted, each magnet **861**, **862** may comprise a single, integral magnet, or it may comprise multiple magnets placed face to face—e.g., with alternating polarities. In general, single integral magnets result in a greater horizontal force (i.e., parallel to the stator plate **804**) and multiple magnets result in greater vertical force (i.e., normal to the stator plate **804**). Accordingly, the direction of the force can be tailored according to requirements and specifications by the number of magnets used to make up the magnets **861**, **862** of the crescent shaped magnet array **860**.

Referring again to FIGS. **8** and **9**, the stator plate assembly **802** includes two power beds **850** with shunt bridges **840** disposed between the crescent shape magnet arrays **860**. Details of each shunt bridge **840** are shown in FIG. **14**. Each shunt bridge **840** preferably includes of a number of Neodymium magnets **842**, being in size; 1"×1"×¼" thick, magnetized through ¼" direction and assembled in attractive mode (i.e., alternating N-S polarity) with a minimum of seven, nine, or more magnets **842** (not necessarily limited to these numbers). Steel wedges **844**, **846** are positioned on each end of the shunt bridge **840**.

Each shunt bridge **840** is oriented with opposite north-south polarity to each crescent shaped magnet array **860**. (See FIG. **9**).

The purpose of the shunt bridge **840** is to shunt the magnetic field of the crescent shape magnet arrays **860** for the back (radially inner) magnetic field of each spinner approaching the power beds **850**. That is, before the spinner cone **830** approaches the power bed **850**, the shunt bridges **840** shunt the magnetic fields of the crescent shaped magnet arrays **860**, which, in the absence of the shunt bridges **840**, would interact magnetically with each other and actually oppose rotation of the spinner arm **800** until the arm is sufficiently within the influence of the power bed **850**. It is therefore preferable that the steel wedges **844**, **846** of the shunt bridges **840** be sufficiently close to the steel wedges **864**, **865** of the crescent shaped magnet arrays **860** so as to accomplish this shunting functionality. When the spinner cone **830** is sufficiently close to the power bed **850**, the proximity of the spinner cone **830** causes the magnetic field of the crescent shaped magnet arrays **860** to interact with the magnetic field of the helical magnet array **820** of the spinner cone **830**, instead of with the magnetic field of the shunt bridge **840**.

A further benefit of the shunt bridge **840**, is to propel the spinner **830** and arm **800** in the desired direction. This is accomplished by way of the interaction of the unlike poles direction directly related to the orientation of the poles on the shunt bridge and the overlapping magnet poles on spinner **830**. The unlike poles create a rotational torque on the spinner **830** that directly translates to gear **806** in the desired direction. This interaction process occurs only for the time where the unlike poles interact.

Details of the booster field magnet **870** are shown in FIG. **15**. Each booster field magnet assembly **870** includes a Neodymium magnet **872** (which may comprise one or more magnets) having, for example, a size 1"×1"×¼" thick, and magnetized thru the ¼" dimension. Steel blocks in size 1"×1"×½" thick (for example) or steel-shape wedges **874**, **876** (wedge shape is optional; rectangular steel blocks may be substituted) are optionally provided on each end of the magnet **872**. The purpose of the steel blocks or steel shape wedges is for blocking or shunting the magnetic field as the magnetic flux circulates from North to South polarity or South to North and acts as a short circuit for the magnetic flux. Without the steel block or steel shape wedge on each end of the booster field magnet assembly the magnetic flux path on each end protrudes outward rather than through the steel block or steel shape wedge and back to the magnet. This type of setup prevents the magnetic flux from opposing the approaching spinner arm **800** making for smoother rotation in clockwise or counter clockwise movement. As explained above with respect to wedges **864**, **865** of the crescent shaped magnet array **860**, however, omitting the wedges **874**, **876** will allow a larger magnetic field around the booster field magnet assembly **870** and will result in an even greater force repelling movement of the spinner **800** into the power bed **850**, but will also result in a greater force rotating the spinner cone **830**. Thus, omitting steel wedges **874**, **876** can result in a greater rotational speed of the spinner cone **830**.

A mounting bracket **878** is provided for mounting the magnet **872** and wedges **874**, **876** to the plate **804**. The bracket **878** is preferably configured to orient the magnet **872** and wedges **874**, **876** at 45 degrees relative to the plate **804**. The mounting bracket **878** is also configured to hold the magnet **872** and the steel wedges **874**, **876** at a desired height above the plate **804** so as to be in desired proximity to the spinner cone **830** and the helical magnet array **820** as each spinner arm **800** passes through the power bed **850**.

The placement of each crescent shaped magnet array **860** and booster field magnet **870** defines a tri-field arrangement defined by the two magnets **861**, **862** on the crescent shaped magnet array **860** and the magnet **872** of the booster field magnet **870**.

The purpose of the steel bar **863** is to separate or stretch the linked magnetic flux fields in between magnets **861** and **862** of the crescent shaped magnet array **860** through dampening of the flux fields, thereby creating a tri-field comprising magnets **861** and **862** of the crescent shaped magnet array **860** and magnet **872** of the booster field array **870**. The separation of the fields by dampening allows the spinner cone **830** to interact with magnetic fields of magnets **861** and **862** (FIG. **13**) and magnet **872** (FIG. **15**). The order of interaction of the helically arranged magnets of the spinner cone **830** with the magnetic fields of the tri-field defined within the power bed **850** would be fields **861**, **872**, **862** for counter clockwise movement of the spinner arm **800** or **862**, **872**, **861** if preferred travel was clockwise.

Details of the auxiliary magnet bed **880** are shown in FIG. **16**. Auxiliary magnet bed **880** includes a magnet **881** (comprising one or more individual magnets) of solid rectangular (preferably square) shape and preferably made from Neodymium and optional steel wedges **882**, **883** (wedge shape is optional; rectangular steel blocks may be substituted) on opposite ends of the magnet **881**. As explained above with respect to wedges **864**, **865** of the crescent shaped magnet array **860**, however, omitting the wedges **882**, **883** will allow a larger magnetic field around the auxiliary magnet bed **880** and will result in an even greater force repelling movement of the spinner **800** into the power bed **850**, but will also result in a greater force rotating the spinner cone **830**. Thus, omitting steel wedges **882**, **883** can result in a greater rotational speed of the spinner cone **830**.

The auxiliary magnet bed **880** is displaced from the boost field provided by the tri-field arrangement defined by the crescent shaped magnet array **860** and booster field magnet **870** and negates a negative resistance from starting or reacting 45 degrees prior to the spinner cone **830** entering the boost field and reduces or eliminates the area of magnetic resistance of the tri-fields to the rotation of the spinner arms **800** down to 25 degrees prior to the spinner cone **830** entering the boost field. The angle by which the auxiliary magnet bed **830** is displaced from the boost field (power bed **850**) can vary as determined by the position that provides the most benefit, but will typically be up to 45 degrees.

A mounting bracket **884** is provided for attaching the auxiliary magnet bed **880** to the plate **804**. The bracket **884** is preferably configured to hold the magnet(s) **881**—inside the bracket **884**—and steel wedges **882**, **883** at a 45 degree orientation with respect to the plate **804**. Magnet(s) **881** may extend beyond the edges of the bracket **884** or may be recessed within the bracket **884**, depending on the desired size of the magnet(s) **881** and bracket **884**. In one embodiment, the magnets **881** comprise square neodymium magnets with dimensions of 1"×1"×¼". A slotted opening **885**, through which a fastener may be inserted into the plate **804**, allows the position and orientation of the magnet bed **880** to be adjusted. As shown in FIG. **9**, in the illustrated embodiment, the auxiliary magnet bed **880** is skewed by an angle $\Theta_A$ (counterclockwise) relative to a true radial orientation. The mounting bracket **884** is also configured to hold the magnet **881** and the steel wedges **882**, **883** at a desired height above the plate **804** so as to be in desired proximity to the spinner cone **830** and the helical magnet array **820** as each spinner arm **800** passes through the power bed **850**.

As shown in FIG. **20**, for more power, a second stator plate **804'** may be mounted above and parallel to stator plate **804** so as to be axially displaced from the stator plate **804** relative to the second axis of rotation (coinciding with the shaft extending perpendicularly from the stator plate **804**). Second stator plate **804'** may include secondary power beds **850'**—each including a crescent shaped magnet array **860'** and a booster field magnet **870'**—that cooperate with power beds **850** to increase the power applied to the spinner arm **800**. In one embodiment, the crescent shaped magnet array **860'** and/or the booster field magnet **870'** of the secondary power bed **850'** are/is angularly offset—e.g., by 5° to 20°, preferably 10° to 15°—with respect to the crescent shaped magnet array **860** and the booster field magnet **870** of the power bed **850**. In addition, the crescent shaped magnet array **860'** and/or the booster field magnet **870'** of the secondary power bed **850'** may not include steel wedges on the ends of the respective magnets, while the crescent shaped magnet array **860** and the booster field magnet **870** of the power bed **850** do include steel wedges on the ends of the respective magnets, or vice versa. Steel wedges—or blocks—may be provided on the ends of the magnets of one power bed **850** or **850'**, the magnets of both power beds **850** and **850'** or neither power bed **850** or **850'**.

The secondary power bed **850'** may further include an auxiliary power bed (such as auxiliary power bed **880**, not shown in FIG. **20**). In one embodiment, an auxiliary power bed of the secondary power bed **850'** may be offset with respect to an auxiliary power bed **880** of the power bed **850**. That is, whereas the auxiliary power bed **880** of the power bed **850** may follow the booster field magnet **870** (relative to the rotational direction of motion of the spinner arm **800**), the auxiliary power bed of the secondary power bed **850'** may precede the booster field magnet **870'**.

Furthermore, the power bed **850** shown in FIG. **9** has polarities of the crescent shaped power bed **860** and the booster field magnet **870** that are opposite (i.e., as shown in FIG. **9**, the right-hand side crescent shaped power bed **86** has "N" polarity at the top end and "S" polarity at the bottom end, the associated (right-hand side) booster field magnet **870** has "S" polarity at the top end and "N" polarity at the bottom end). The inventor has determined that the crescent shaped magnet array **860'** and the booster field magnet **870'** of the secondary power bed **850'** of the second stator plate **804'** should have like polarities. Having like polarities on the crescent shaped magnet array **860'** and the booster field magnet **870'** of the secondary power bed **850'** of the second stator plate **804'** decreases or eliminates pull back or negative flux interaction of the secondary power bed **850'** with the spinner **830** which would urge the spinner to travel in opposite preferred direction of travel after passing through the crescent shaped magnet array **860'** and the booster field magnet **870'** of the secondary power bed **850'**.

As shown in FIG. **19**, two spinner cones **830**, **830'** can be mounted, end to end, on the same shaft, with the wide or narrow ends of the cones facing each other. The spinner cones **830**, **830'** include helical magnet arrays **820**, **820'**, respectively. A steel disc **832** is preferably provided between the coupled cones for shunting the magnetic flux from each spinner cone. The steel disc between the spinner cones' acts as a short path for magnetic flux as flux lines circulate on back of each spinner cone from South-Pole to North-Pole or vice versa. In addition the steel disc **832** between the spinner cones in this arrangement improves the magnetic flux on the top spinner magnets. The magnetic flux of the spinner on the back without the steel disk would permeate outward away from the back magnets as the flux lines circulate from North to South or South to North and magnetic flux will leak from one spinner cone to the other. The steel disk between the spinner cones also prevents the same polarity facing each other from back of the spinner cones and from bucking each other, thus reducing magnetic flux from the helical magnet array on the outer surface of the spinner cones. This arrangement of spinner cones has the potential to provide more power and torque and decreases the negative resistance significantly.

FIG. **21** illustrates an alternate embodiment in which two spinner arms **800**, **800'** are stationary (non-rotating) (each spinner cone spins about its respective axis) and the plate **904** rotates, instead of the spinner arms rotating as described above.

The spinner cone **830** of the stator plate assembly **802** shown in FIGS. **8** and **9** includes a helical magnet array **820** that comprises a double row of Neodymium Iron Boron (NdFeB) magnets of any grade preferably of highest grade available with Nickel (Ni) Plating or coating or triple plating Nickel-Copper-Nickel (Ni—Cu—Ni) for some environment application. In some cases top coating of epoxy on top of triple Nickel-Copper-Nickel plating is provided for a better protection of magnets.

As shown in FIGS. **10-12**, the array **820** includes an inner row of magnets **825** and an outer row of magnets **826** mounted on a helical mounting backing **828**. In a non-limiting example, magnets **825**, **826** are rectangular in shape, e.g. 1"×1"×¼" thick, magnetized through the ¼" direction or 1¼" long×1" wide×¼" thick, magnetized through ¼" direction. Magnets could also be circular in shape 1" round×¼" thick, magnetized through ¼" direction. Each magnet may include a countersunk hole for mounting the magnet to the spinner cone **830** or mounting backing **828** by means of a screw or other fastener.

The inner row of magnets **825** and the outer row of magnets **826** are preferably oriented so that the outer face (the pole face) of each inner row magnet **825** is generally parallel to the pole face of the magnets **861**, **862** of the crescent shaped magnet array **860** as the spinner cone **830** passes through the power bed **850** and the inner row magnet **825** is on a portion of the spinner code **830** placing the magnet in direct proximity to the magnets **861**, **862** as the spinner cone rotates, and the pole face of each outer row magnet **826** is generally parallel to the pole face of the magnet(s) **872** of the booster field magnet **870** and pole face of the magnet **881** of the auxiliary magnet bed **880** as the spinner cone **830** passes through the power bed **850** and the outer row magnet **826** is on a portion of the spinner code **830** placing the magnet in direct proximity to the magnets **872**, **881** as the spinner cone rotates. The mounting brackets **866**, **878**, and **884** are adjustable so as to accommodate spinner cones of different configuration (size, angular orientation and shape) to provide a desired gap (of, e.g., ¼ inch) between the inner magnets **825** and the magnets **861**, **862** and between the outer magnets **826** and magnets **872** and **881**. In one embodiment, mounting brackets **866** and **878** are connected to each other or comprise a single, integral bracket for mounting magnets **861**, **862**, and **872**.

Although FIG. **10** shows magnets **825** and **826** having opposite polarities "N" and "S", respectively, on their outwardly facing surfaces, this is not always required, and for some configurations the outwardly facing surfaces may have like polarities. Furthermore, it may not be required for all applications that the inner magnets **825** and/or the outer magnets **826** be provided along the entire length of the helix on the spinner **830**. In some configurations, the inner magnets **825** and/or the outer magnets **826** may be provided only along continuous portion or discontinuous portions of the helical path. The number of magnets **825** or **826**, i.e., the length of the helix covered by magnets, is directly responsible for the length of time that the spinner cone **830** interacts with the crescent shaped power bed **860** and the booster field bed **870**.

As shown in FIGS. **17** and **18**, the magnets of the inner row **825** and magnets of the outer row **826** may be mounted on a double row of steps or risers **832**, **834**, preferably oriented at 45 degrees with respect to plate **804** and each tilted at about 15-25 degrees incline to allow slight overlap of the magnets **825**, **826** in the helical array. The depth of steps or risers **832**, **834**, should be no more than ⅔ the thickness of magnets **825**, **826**.

The magnets are placed on a spinner and fastened with flat head magnetic type steel screws **827** or magnetic type stainless steel screws.

While various embodiments/variations of the invention have been described above, it should be understood that they have been presented by way of example only, and not limitation. Thus, the breadth and scope of the invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

**1**. An apparatus for coupling magnetic forces into motive force, the apparatus comprising:

a spinner arm comprising:

a helical array of magnets having a helical axis;

a spinner arm shaft onto which said helical array of magnets is mounted, wherein said spinner arm shaft has a longitudinal axis that is coincident with the helical axis and wherein said spinner arm shaft is mounted so as to be rotatable about a first axis of rotation coinciding with its longitudinal axis and to be rotatable about a second axis of rotation that is transverse to the longitudinal axis; and

a magnetic power bed comprising a first magnetic boost element and a second magnetic boost element, wherein said first and second magnetic boost elements are positioned with respect to said spinner arm such that at least a portion of said helical array of magnets will pass between said first and second magnetic boost elements as said spinner arm rotates about the second axis of rotation and wherein said helical array of magnets and said first and second magnetic boost elements are cooperatively arranged so that magnetic interaction between said helical array of magnets and said first and second magnetic boost elements causes said spinner arm and said helical array of magnets to rotate about the first axis of rotation as at least a portion of said helical array of magnets passes between said first and second magnetic boost elements, and



wherein said first and second magnetic boost elements define a tri-field arrangement of magnetic flux whereby said first magnetic boost element comprises two magnetic blocks separated by a magnetically-responsive material and said second magnetic boost element comprises a single magnetic block.

**2**. The apparatus of claim **1**, wherein said first magnetic boost element is located radially inwardly of said second magnetic boost element relative to said second axis of rotation.

**3**. The apparatus of claim **2**, wherein said first magnetic boost element and said second magnetic boost element are radially aligned relative to said second axis of rotation.

**4**. The apparatus of claim **1**, wherein said first magnetic boost element comprises a crescent shaped magnet array including a first arc-shaped magnetic block and a second arc-shaped magnetic block with a steel bar disposed between said first and second arc-shaped magnetic blocks.

**5**. The apparatus of claim **4**, wherein said crescent shaped magnet array further comprises a first steel shunt element disposed on an end of said first arc-shaped magnetic block opposite said steel bar and a second steel shunt element disposed on an end of said second arc-shaped magnetic block opposite said steel bar.

**6**. The apparatus of claim **5**, wherein said first and second steel shunt elements are wedge shaped.

**7**. The apparatus of claim **4**, wherein at least one of said first and second arc-shaped magnetic blocks comprises a single integral magnet.

**8**. The apparatus of claim **4**, wherein said first and second magnetic blocks comprise Neodymium.

**9**. The apparatus of claim **1**, wherein said second magnetic boost element comprises a booster field magnet comprising a single magnetic block.

**10**. The apparatus of claim **9**, wherein said magnetic block of said booster field magnet comprises a single, integral magnet.

**11**. The apparatus of claim **9**, wherein said magnetic block of said booster field magnet comprises Neodymium.

**12**. The apparatus of claim **9**, wherein said booster field magnet further comprises steel shunt elements located on opposite ends of said magnetic block.

**13**. The apparatus of claim **12**, wherein said steel shunt elements are wedge shaped.

**14**. The apparatus of claim **1**, wherein said magnetic power bed further comprises an auxiliary magnet array disposed at a position that is angularly offset about said second axis of rotation from said first and second magnetic boost elements.

**15**. The apparatus of claim **14**, wherein said auxiliary magnet array comprises a single magnetic block.

**16**. The apparatus of claim **15**, wherein said magnetic block of said auxiliary magnet array comprises a single, integral magnet.

**17**. The apparatus of claim **15**, wherein said magnetic block of said auxiliary magnet array comprises Neodymium.

**18**. The apparatus of claim **15**, wherein said auxiliary magnet array further comprises steel shunt elements located on opposite ends of said magnetic block.

**19**. The apparatus of claim **18**, wherein said steel shunt elements are wedge shaped.

**20**. The apparatus of claim **1**, further comprising a secondary magnetic power bed axially displaced from said magnetic power bed with respect to said second axis of rotation, said secondary magnetic power bed comprising a first magnetic boost element and a second magnetic boost element, wherein said first and second magnetic boost elements of said secondary magnetic power bed are positioned with respect to said spinner arm such that at least a portion of said helical array of magnets will pass between said first and second magnetic boost elements of said secondary magnetic power bed as said spinner arm rotates about the second axis of rotation and wherein said helical array of magnets and said first and second magnetic boost elements of said secondary magnetic power bed are cooperatively arranged so that magnetic interaction between said helical array of magnets and said first and second magnetic boost elements of said secondary magnetic power bed causes said spinner arm and said helical array of magnets to rotate about the first axis of rotation as at least a portion of said helical array of magnets passes between said first and second magnetic boost elements of said secondary magnetic power bed, and

wherein said first and second magnetic boost elements of said secondary magnetic power bed define a tri-field arrangement of magnetic flux whereby said first magnetic boost element comprises two magnetic blocks separated by a magnetically-responsive material and said second magnetic boost element comprises a single magnetic block.

**21**. The apparatus of claim **20**, wherein the first and second magnetic boost elements of said secondary magnetic power bed are angularly offset with respect to said first and second magnetic boost elements of said magnetic power bed.

**22**. The apparatus of claim **1**, wherein said helical array of magnets is mounted on a cone.

**23**. The apparatus of claim **1**, wherein said helical array of magnets comprises a first row of magnets and a second row of magnets, both extending along a helical path.

**24**. The apparatus of claim **23**, wherein each of the magnets of said first row of magnets is arranged at an angle with respect to each of the magnets of said second row of magnets.

**25**. The apparatus of claim **24**, wherein the magnets of said first and second rows of magnets are mounted on a helical mounting backing.

**26**. The apparatus of claim **1**, further comprising a hub within which said spinner arm shaft is mounted and configured to allow rotation of said spinner arm shaft about the first axis of rotation.

**27**. The apparatus of claim **26**, further comprising:

a stator plate on which said magnetic power bed is mounted; and

a shaft extending perpendicularly from said stator plate and having a longitudinal axis coincident with said second axis of rotation,

wherein said hub is coupled to said perpendicular shaft so as to be rotatable about the second axis of rotation.

**28**. The apparatus of claim **1**, wherein the pole face of each magnet of the helical array of magnets is parallel to a pole face of a magnetic block of the first or second magnetic boost element during at least a portion of the time the helical array of magnets is passing between the first and second magnetic boost elements.

**29**. An apparatus for coupling magnetic forces into motive force, the apparatus comprising:

a first spinner arm comprising:

a first helical array of magnets having a helical axis;

a first spinner arm shaft onto which said first helical array of magnets is mounted, wherein said first spinner arm has a longitudinal axis that is coincident with the helical axis and wherein said first spinner arm shaft is mounted so as to be rotatable about a first axis of rotation coinciding with its longitudinal axis and to be rotatable about a second axis of rotation that is transverse to the longitudinal axis;

a second spinner arm comprising:

a second helical array of magnets having a helical axis;

a second spinner arm shaft onto which said second helical array of magnets is mounted, wherein said second spinner arm has a longitudinal axis that is coincident with the helical axis and with the longitudinal axis of said first spinner arm shaft and wherein said second spinner arm shaft is mounted so as to be rotatable about the first axis of rotation and to be rotatable about the second axis of rotation;

a first magnetic power bed comprising a first magnetic boost element and a second magnetic boost element, wherein said first and second magnetic boost elements of said first magnetic power bed are positioned with respect to said first and second spinner arms such that at least a portion of each of said first and second helical arrays of magnets will pass between said first and second magnetic boost elements of said first magnetic power bed as said first and second spinner arms rotate about the second axis of rotation and wherein said first and second helical arrays of magnets and said first and second magnetic boost elements of said first magnetic power bed are cooperatively arranged so that magnetic interaction between said first and second helical arrays of magnets and said first and second magnetic boost elements of said first magnetic power bed causes each spinner arm and helical array of magnets to rotate about the first axis of rotation as at least a portion of each of said first and second helical arrays of magnets passes between said first and second magnetic boost elements of said first magnetic power bed; and

a second magnetic power bed comprising a first magnetic boost element and a second magnetic boost element, wherein said first and second magnetic boost elements of said second magnetic power bed are positioned with respect to said first and second spinner arms such that at least a portion of each of said first and second helical arrays of magnets will pass between said first and second magnetic boost elements of said second magnetic power bed as said first and second spinner arms rotate about the second axis of rotation and wherein said first and second helical arrays of magnets and said first and second magnetic boost elements of said second magnetic power bed are cooperatively arranged so that magnetic interaction between said first and second helical arrays of magnets and said first and second magnetic boost elements of said second magnetic power bed causes each spinner arm and helical array of magnets to rotate about the first axis of rotation as at least a portion of each of said first and second helical arrays of magnets passes between said first and second magnetic boost elements of said second magnetic power bed,

wherein said first and second power beds are located at diametrically opposed positions with respect to the second axis of rotation,

wherein said first and second magnetic boost elements of said first magnetic power bed define a first tri-field arrangement of magnetic flux whereby said first magnetic boost element comprises two magnetic blocks separated by a magnetically-responsive material and said second magnetic boost element comprises a single magnetic block, and wherein said first and second magnetic boost elements of said second magnetic power bed define a second tri-field arrangement of magnetic flux whereby said first magnetic boost element comprises two magnetic blocks separated by a magnetically-responsive material and said second magnetic boost element comprises a single magnetic block.

**30**. The apparatus of claim **29**, further comprising a shunt bridge extending between said first and second magnetic power beds and configured to provide a pathway for magnetic flux to flow from said first magnetic power bed to said second magnetic power bed.

**31**. The apparatus of claim **30**, wherein said shunt bridge comprises a plurality of magnets arranged side-by-side with alternating polarities.

**32**. The apparatus of claim **31**, wherein said shunt bridge further comprises a steel shunt element located at each opposite end of said shunt bridge.

**33**. The apparatus of claim **30**, comprising two shunt bridges extending between said first and second magnetic power beds and disposed on diametrically opposed sides of said second axis of rotation.

* * * * *